PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT
COWBOY HEAVEN DEVELOPMENT
PHASE 3-C: Areas III, IV, and V
MOONLIGHT BASIN RANCH
BIG SKY, MONTANA

Prepared for:

Moonlight Basin Ranch
P.O. Box 1369
Ennis, Montana 59729

February 8, 2007

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• Geotechnical Engineering • Geology

February 8, 2007

Lee Poole
Moonlight Basin Ranch
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Ennis, Montana 59729

RE: GEOTECHNICAL INVESTIGATION, COWBOY HEAVEN PHASE 3-C, AREAS III, IV, AND V, MOONLIGHT BASIN RANCH, BIG SKY, MONTANA.

Dear Lee:

We are pleased to present this report on our geotechnical investigation for the Cowboy Heaven Phase 3-C Development Areas III, IV, and V, Moonlight Basin Ranch, Madison County, Montana. Two copies are enclosed. The report describes site conditions and presents conclusions and recommendations.

If you have any questions about this report, or if we may provide other services to you, please contact us. As the project progresses, we will be available to answer questions for you.

Respectfully submitted,

WOMACK & ASSOCIATES, INC.

MONTANA
WESLEY R. WOMACK 8312PE LICENSED PROFESSIONAL ENGINEER

2-8-07

Ray Womack, P.E.
Enclosure: Report

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EXECUTIVE SUMMARY

The purpose of this investigation was to evaluate subsurface conditions for three specific areas of the Cowboy Heaven development Phase 3-C: 1) Area III 2) Area IV 3) Area V. The geologic map has also been updated to reflect results of other investigations performed at Cowboy Heaven over the past few years. Five test pits were excavated to investigate soil and groundwater conditions. The Cowboy Heaven development area is situated primarily on "dip slopes" on the north side of Lone Mountain. A relatively small area along the west edge of the subdivision is located on ancient dormant landslides (Exhibit 1). The rest of the proposed development area is located on ground that appears to be stable under current conditions. Subsurface conditions are variable even in the mapped areas, and site-specific subsurface investigations are strongly recommended for individual building sites throughout the development area. Limited site access at the time of the investigation precluded detailed exploration. This report is believed to be adequate for planning and subdivision design. Detailed foundation design for buildings is likely to require lot-specific exploration.

Of the five test pits, only one encountered material that could be considered suspect with regard to previous mass movement. The majority of the test pits encountered bedrock that was either flat-lying or inclined with a sub-perpendicular orientation relative to the local slope. Areas IV and V are underlain by coherent sandstone and weathered claystone bedrock. Area III is underlain by northward-dipping shale, claystone, and bentonite with some evidence of shearing apparent in the bentonite. The sheared bentonite is near the surface and can be addressed by local over-excavation of foundation cuts.

Areas IV and V that are underlain by sandstone bedrock appear to be acceptable for development using standard construction methods. For areas underlain by shallow bedrock with bentonite beds, some modification to foundation design and subgrade improvement may be required depending on local site conditions. In most cases the selected technique will probably be to "key" the foundation through the bentonitic clay layers into the underlying bedrock, using relatively short drilled piers or engineered fill to replace the soil. Multiple bentonite beds often occur in the bedrock, and it is important to verify that all shear zones and shallow bentonite beds are penetrated by the foundation elements.

1.0 INTRODUCTION

As authorized by Moonlight Basin Ranch, Womack & Associates, Inc. conducted a preliminary geotechnical investigation for the proposed Cowboy Heaven Phase 3-C Development, Areas III, IV, and V in Section 24, T6S, R2E, Madison County, Montana. The scope of services included reconnaissance level field mapping, and logging and sampling of 5 test pits. The purposes of this investigation are to verify the thickness and consistency of potential landslide deposits observed during previous investigations, document subsurface soil conditions in previously unexplored areas, evaluate soil-engineering properties, and provide preliminary recommendations for site development. Considering the variability in subsurface conditions and gaps between exploration points, the report should be used for planning and preliminary design purposes only. Site-specific geotechnical investigations will be required for final design of individual structures. This work complements the previous investigation undertaken for Cowboy Heaven Phase 3A to the west.

This investigation targeted only specific areas of the overall development in Section 24. A large portion of Section 24 has been evaluated during previous geotechnical investigations including the geotechnical investigations for Moonlight Lodge and Saddle Ridge Townhouses (Womack & Associates, 1996, 1998, and 1999), preliminary geologic hazards evaluation from aerial photographs for a large area of Moonlight Basin (Womack & Associates, 1998), preliminary investigation of Cowboy Heaven Phase 2 and 3 (Womack & Associates, 2001), and preliminary investigation of Cowboy Heaven Phase 3 (Womack & Associates, 2002). Where appropriate, subsurface information, laboratory test results, and geologic interpretations from the previous investigations are incorporated into this report; however, the previous studies should be referenced for conclusions and recommendation for areas outside the specific locations addressed in this report. Exhibit 1 represents a compilation of geologic interpretations from our current and previous investigations and supercedes all previous versions of this map.

2.0 PROPOSED CONSTRUCTION

According to the preliminary plat for Cowboy Heaven Phase 3-C, Area III is slated for development as single-family homesites and condominiums. There do not appear to be plans on the current plat for development of Areas IV and V. Specific plans and detailed foundation designs are unavailable. Depending of the subsurface conditions on each lot, foundation elements may include perimeter spread footings with stem walls and concrete slab-on-grade floors, reinforced concrete mat foundations, or deep foundations such as helical or drilled piers. Foundation subgrade improvement and remedial slope stabilization measures may be required on some lots prior to construction. Coherent sandstone and claystone bedrock underlie much of the area, but the limited presence of landslide debris and shale bedrock with weak bentonitic clay layers indicates that the proposed homesites should be located and designed to cater to specific site conditions.

3.0 INVESTIGATION PROCEDURE

3.1 Analysis of Aerial Photographs

Recent (August, 1994; October, 1998) large format black-and-white aerial photographs were viewed stereographically to identify landslide features and glacial terrain. Geologic features identified on the air photos, refined using information from our reconnaissance field mapping and preliminary subsurface investigation, were transferred onto a topographic base map (Exhibit 1).

3.2 Field Investigation

Field work conducted on June 23, 2005, consisted of excavation and logging of five exploratory test pits. Data from earlier reports were utilized where appropriate. A preliminary geotechnical investigation for Cowboy Heaven was addressed in a report by Womack & Associates in September 2001. The test pits were spread across the three areas, with two in Area III, one in Area IV, and two in Area V. The test pits were excavated to practical refusal or to the reach limit of the trackhoe at depths ranging from 8 to 12 feet. The excavation equipment was provided by Moonlight Basin Ranch. Test pit locations are shown on Exhibit 1. Refer to Appendix B for copies of logs from earlier reports.

Soil types, thicknesses, and consistencies were observed and documented by an Engineering Geologist. Field conditions were described for all soil and rock types observed and representative samples were obtained from the soil horizons. Note that site conditions are highly variable and actual soil conditions across the site will differ from those represented in the borehole and test pit logs.

3.3 Laboratory Analysis

No laboratory tests were conducted for this investigation. Based our experience in the area, laboratory testing was judged unnecessary.

3.4 Report Preparation

The report presents results of air photo analysis and geologic mapping, subsurface exploration, engineering analysis, and recommendations for development and possible mitigation measures.

4.0 SITE CONDITIONS

4.1 Description

Areas III, IV, and V of the Cowboy Heaven Phase 3 Development are located on north and east-facing slopes of a convex hillside at elevations of 7,880' to 8,000'. Local slope angles vary from 6° (Area V) to 35° (Area III). Current land cover includes a mix of open meadow and mature coniferous forest. No potential geologic concerns were identified at areas IV and V appear to be devoid of potential geologic concerns, as these areas are underlain, in the area tested, by coherent flat-lying sandstone and claystone bedrock within three to five feet of the ground surface. No evidence of shearing or other mass movement is apparent. Area III is not quite so straightforward, as our investigation here encountered a sheared bentonite zone within shale bedrock. This area is very steep, as well. No landslide deposits are apparent and coherent bedrock is within seven feet of the ground surface. Site-specific investigations will be required for new construction in Area III and buildings will likely need to be keyed to coherent bedrock underlying the bentonite.

4.2 Geology

The basin to the north of Cowboy Heaven is the topographic expression of the northwest-trending Lower Basin geological syncline (trough) that parallels the Spanish Peaks uplift to the northeast (Montagne, 1976). It has been glaciated and is covered in most places by a veneer of glacial till.

The Cowboy Heaven development area is underlain by thinly bedded to laminated shale of the Cretaceous Colorado Group (Bolm, 1969), possibly within the subdivision of the Group named the Albino Formation or in the undifferentiated shales and siltstones above the Albino. The Albino Formation is described as non-resistant claystone, shale, and sandstone, with siliceous ash layers that have weathered to bentonitic clay. Numerous bentonite beds have been encountered in the shale. These appear to have provided the zones of weakness that sheared when the landslides moved. Near the development area, the sedimentary rocks are generally inclined (dip) to the north at about 0 to 20 degrees, roughly parallel to the slope of the ground surface. The dip of the layered bedrock appears to increase locally to about 30 to 40 degrees toward Lone Mountain to the south.

The Albino Formation and other late Cretaceous age rocks in this region have been extensively intruded by andesitic volcanic rocks of the Tertiary-age Lone Mountain igneous intrusive (Swanson, 1950). The andesite volcanic rock has invaded the older shales, and is referred to as a "Christmas tree laccolith", which in cross-section has branching vaults resembling the limbs of a tree. On the slopes north of Lone Mountain, layers of andesite have been injected along the bedding of the shale, and rocks believed to be andesite were observed in contact with shale in several test pits excavated in 1999 south of about elevation 8,240 (Exhibit 1).The intrusion dilates the shale, such that the dip increases closer to Lone Mountain and decreases downslope.

4.3 Landslides

Kehew, et al (1971) and Montagne (1976) did not map the large landslides on the north slopes of Lone Mountain. A preliminary map of the landslides prepared by Womack & Associates, Inc. (1998) included a slide lobe in the western portion of the proposed development area. The geomorphic expressions of the landslide deposits include hummocky topography, closed depressions, ponds, and small head scarps (slope breaks). The approximate locations of the landslides at Cowboy Heaven Phases 2 through 4 are shown on Exhibit 1.

The landslide deposits appear to be relatively old (perhaps thousands of years) and inactive. The ages of the landslides are unknown. Bailey (1971) observed that many landslide failures in this region of the northern Rocky Mountains were caused by an increase in available moisture and a higher water-table level in the Pleistocene (about 1.8 million years to 6,000 years before present). The landslide deposits at Cowboy Heaven are typical of large ancient landslide failures throughout the northern Rocky Mountains. Many of the landslides probably occurred immediately after the withdrawal of the ice following the last glacial period (approximately 10,000 years before present).

The landslides appear to consist predominantly of "dip slope failures"; i.e., sliding has occurred along weak beds in the shale, which is oriented approximately parallel to the slope. As discussed in Section 4.2 (Geology), the Albino Shale contains numerous bentonitic clay beds, and some of the test pits encountered one or two bentonite layers up to 3 feet thick. The test pits excavated during previous investigations that penetrated the slide deposits consistently encountered a sheared bentonite layer along the base of the debris that conforms to the bedding of the underlying rock. In some cases (e.g., TP01-9 and TP01-14, Womack & Associates, 2002), virtually intact layers of shale ("glide blocks") up to 7 feet thick had clearly been displaced. A "glide block" is a relatively intact section of rock mass that has moved downslope with translational displacement along a planar (bedding) failure surface. Therefore, encountering bedrock is not necessarily an indication that an excavation has reached the bottom of the landslide debris. No landslide terrain features were encountered in the preliminary investigation of Phase 3 Areas III, IV, and V.

4.4 Area III

Two test pits were excavated in the vicinity of Area III. Test Pit locations for test pits TP05-1 and TP05-2 are shown on Exhibit 1. Subsurface conditions are depicted on logs included in Appendix A. Test pits TP05-1 and TP05-2 were excavated to depths of 10 and 12 feet, respectively. Test pit TP05-1 encountered interbedded claystone and shale dipping north at an angle of about 38° (oriented perpendicular to the local ground surface, which faces east). Test pit TP05-2 encountered highly fractured shale bedrock with a single highly sheared bentonite bed. The shale was described as slightly moist, weak, weathered, and highly fractured. The bentonite bed was 0.7 to 3.5 feet thick and was described as slightly moist, light brown, highly plastic, highly fractured weathered claystone that appears

sheared from folding. The presence of sheared bentonite in this area indicates the need for further investigation in advance of construction. The orientation of the beds perpendicular to the local slope reduces the likelihood of landslide movements at this site. Aerial photo analysis did not indicate the presence of landslide features at Area III. Buildings at this site will likely need to be keyed into the shale below the bentonite layer, by means of over-excavation or pile systems.

4.5 Area IV

For this investigation, one test pit was excavated in the northern portion of Area IV (test pit TP05-5; Exhibit 1). The test pit encountered flat-lying strata with no indication of previous mass movement. The upper 4.8 feet of the soil column is composed of topsoil and residual claystone, with sandstone bedrock below to the bottom of the hole at 8 feet. The topsoil is 1 foot thick and was described as moist, black, soft silt with organic material and roots. The residual claystone is essentially a soil due to weathering processes and was described as light tan, soft to firm clay. The sandstone encountered from 4.8 feet to 5.4 feet was described as red brown and very strong with 2 to 6 inch joint spacing and 1 to 2 inch bedding. From 5.4 feet to the bottom of the hole at 8 feet, the sandstone was described as medium brown and weak with 6 to 8 inch joint spacing and 2 to 4 inch bedding. Test pit logs detailing site conditions are attached in Appendix A. Removal of the topsoil and residual claystone from below all foundation footings will likely be necessary for new construction. The sandstone bedrock, while logged as very weak rock, is still considerably stronger than most soils and will likely provide adequate bearing conditions in this area. Site-specific investigations are recommended for individual buildings in Area IV.

4.6 Area V

Two test pits were excavated in Area V, both to depths of 8 feet (TP05-3 and TP05-4; Exhibit 1). The test pits encountered flat-lying strata with no indication of previous mass movement. Test pit TP05-3 encountered coherent bedrock at 5 feet below the ground surface. The upper portion of the soil column in test pit TP05-3 was composed of 0.5 feet of topsoil underlain by 2 feet of colluvium, which in turn is underlain by 2.5 feet of claystone. The colluvium was described as moist, brown, soft, plastic clay with sand and gravel. The claystone was described as moist, light brown, weathered claystone with some sandstone in a soft clayey matrix. The colluvium and claystone contain too much plastic material be appropriate bearing layers for foundations. As a result, the upper 5 feet of the soil column will likely need to be removed below foundation footings down to the coherent sandstone bedrock below. TP05-4 is located directly upslope of TP05-3 and encountered bedrock at a depth of 3 feet with no colluvial cover, suggesting that colluvium thickness increases downslope.

Test Pit TP05-4 encountered strong sandstone bedrock at a depth of 3 feet, continuing to the bottom of the hole at 8 feet. The upper 3 feet of the soil column is composed of 0.5 feet of topsoil and 2.5 feet of weathered claystone. The weathered claystone was described as moist, orange/brown, soft, plastic clay with some 3-inch minus sand and gravel. The sandstone was described as moist, medium brown, strong, nearly horizontally bedded, jointed angular fragments with 10 inch maximum diameter. The weathered claystone should be removed from beneath foundation footings due to its high plastic content. The sandstone bedrock encountered at 3 feet will provide good bearing conditions. We recommend site-specific investigations for new construction in Area V. Detailed logs describing field conditions from this preliminary investigation are attached in Appendix A.

4.7 Groundwater

At the time of our investigation, groundwater was not encountered in any of the pits. The site investigation was performed during a time of year that is typically associated with the seasonal groundwater high. Seepage may be more widespread and shallow during wet years. Seasonal wet surface areas mapped by others are shown on Exhibit 1.

4.8 Earthquakes and Seismicity

A northwest trending earthquake zone known as the Intermountain Seismic Belt (Smith and Arabasz, 1991) crosses Western Montana. The seismic belt enters Montana in the south near the Yellowstone Park-Hebgen Lake area, trends northward to the vicinity of Bozeman, and continues through Helena and Kalispell. Big Sky and the proposed development are located in the center of the seismic zone; however, active faults have not been identified in the Big Sky basin and historically no major earthquake epicenters have been located in the immediate area.

A recent national seismicity study by the U.S. Geological Survey (USGS, 2002) estimated peak horizontal accelerations on bedrock of 0.21g and 0.40g for earthquake events predicted to have risks of occurrence of 10% and 2% respectively in 50 years.

Ground motion accelerations and a design response spectrum were derived for the project site in accordance with the procedure defined in the 2006 International Building Code (IBC). The provisions of the 2006 IBC are intended to provide uniform levels of performance for structures, depending on their occupancy and use and the risk inherent to their failure. The approach adopted in the 2006 IBC is intended to provide a uniform margin of safety against collapse at the *design* ground motion. The *design* earthquake ground motion is selected at a ground shaking level that is 2/3 of the *maximum considered earthquake* (MCE) ground motion, which has a likelihood of exceedance of 2 percent in 50 years (a return period of about 2,500 years). The Site Ground Motion and Design Response Spectra differ depending on the earth material being considered as a function of varying shear wave velocities. The site is classified based on the

upper 100 feet of the soil and bedrock column. Based our investigations and published geology of the area (Bolm, 1969), we assign Areas III, IV, and V to a Very Dense Soil and Soft Rock Profile (Site Class C). Design Response Spectra are presented in Figure 1.

Earthquake Loads – Site Ground Motion and Design Response Spectrum 2006 International Building Code [2]

Cowboy Heaven Phase 3: Areas III, IV, and V.
Approximate Site Location: **Latitude = N 45.297°, Longitude = W 111.419°**

Mapped Maximum Considered Earthquake (MCE) Spectral Response Acceleration Parameters (USGS 2002):

Short Period (S_s) = **0.97**[1]
1-Sec Period (S_1) = **0.31**[1]

Site Class Definition: **C – Very Dense Soil and Soft Rock Profile**

Site Coefficients and Adjusted MCE Spectral Response Acceleration Parameters:

S_{MS} = **0.98** F_a = **1.01** *interpolated from table
S_{M1} = **0.46** F_V = **1.49** *interpolated from table

Design Spectral Response Acceleration Parameters

S_{DS} = **0.65**
S_{D1} = **0.31**

[1] Probabilistic ground motion values (2% PE in 50 years) were obtained from the U.S.G.S web site; 2002 acceleration data.
[2] 2006 International Building Code, Chapter 16, Section 1615 - Earthquake Loads – Site Ground Motion.

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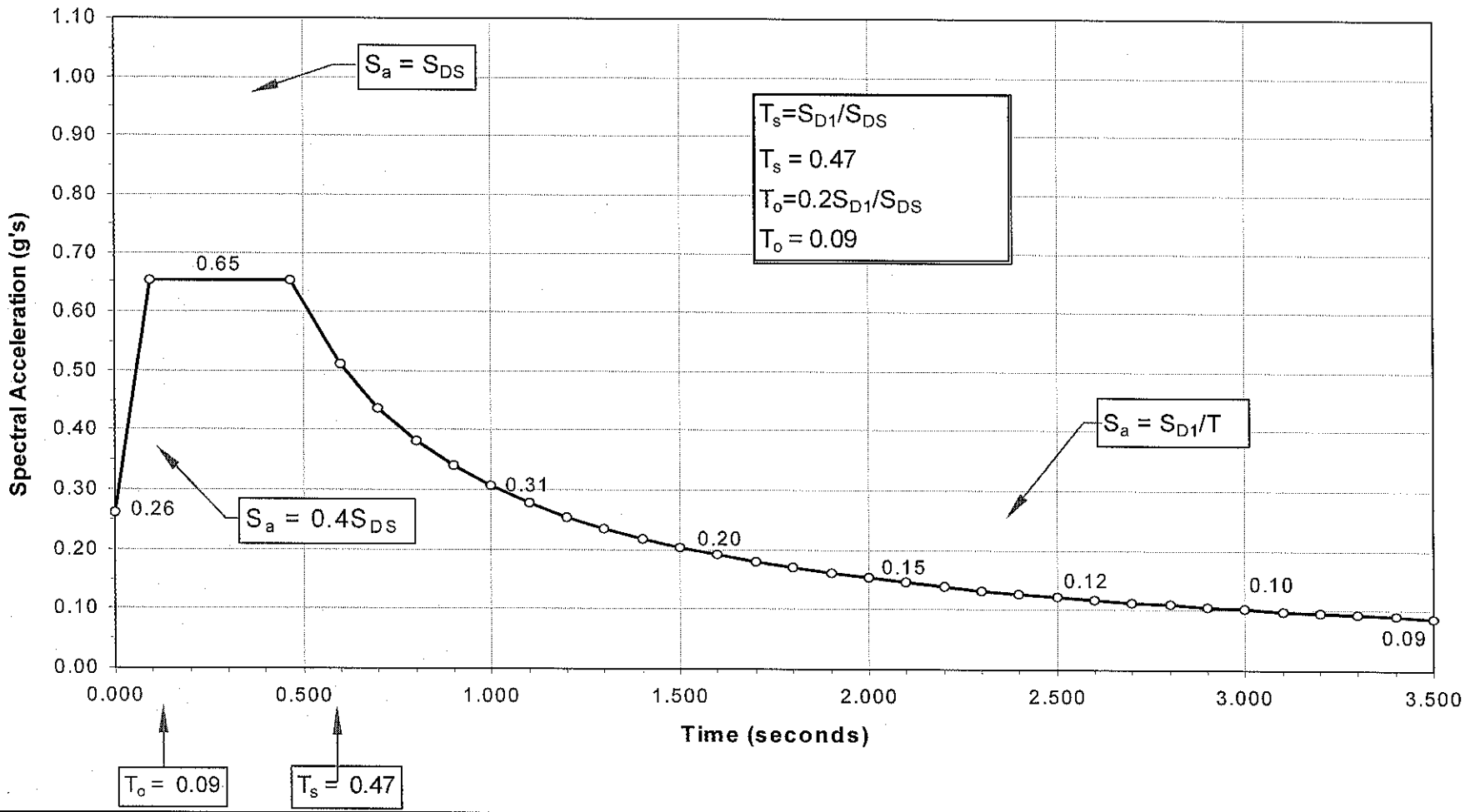
Design Response Spectrum (2006 IBC) - Site Class C Cowboy Heaven Phase 3-C: Areas III, IV, and V



Preliminary Geotechnical Investigation, Cowboy Heaven Phase 3-C: Areas III, IV, and V Moonlight Basin, Montana	DESIGN RESPONSE SPECTRUM	FIGURE 1

5.0 ENGINEERING ANALYSIS

The engineering analyses are based on a limited number of sparsely distributed data points and are suitable for preliminary design only.

5.1 Consolidation/Swell Potential

No consolidation and swell testing was performed for this study. Laboratory test results from previous investigations indicate that the plastic clay samples observed in some of the test pits are expansive, but the high antecedent moisture content (25% or greater) may limit the swell potential. However, if significant drying of the soils occurs during construction, a high swell potential may result. Moderate consolidation may also be expected if footings are placed on soft plastic soil horizons. As shown on Exhibit 1 and test pit logs in Appendix A, a bentonitic clay bed was observed only in test pit TP05-2 in the northern portion of Area III, but may occur elsewhere. These materials are highly expansive and become very weak when wet.

5.2 Bearing Capacity

Bearing capacity of soil refers to its ability to resist shear failure under load. Preliminary bearing capacities for the site may be on the order of 3,000 psf for shallow foundation elements placed on the variable soil deposits and 5,000 psf if footings are placed on intact bedrock. Because the conditions are locally variable, we recommend evaluation of each building site for specific site conditions to support final design. Depending on the specific conditions at any given site, a variety of foundation designs may be appropriate. If weak or expansive materials are encountered at footing level, a replacement fill may be appropriate to key the foundations into the bedrock. Minimum footing depths should be designed to satisfy local codes and building requirements for prevention of frost heave. In some cases a deep foundation system may be preferable.

5.3 Lateral Pressures

Lateral pressures were calculated using methods suggested by Bowles (1996). Equivalent fluid pressures (γK) will vary depending on the soil types and the slope of the ground surface adjacent to foundation or retaining walls. Lateral pressure increases when the ground surface slopes toward the wall and vice versa. Lateral pressures were calculated for at rest, active, and passive conditions for level ground and sloping ground, assuming a surface slope adjacent to the foundation walls of about 11° (20%). Actual pressures will depend on the building location and final grading plans. Lateral pressures on retaining walls from earthquakes were estimated using the Mononobe-Okabe equations (Bowles, 1996; Duncan et al, 1990). Because the maximum acceleration occurs only briefly during an earthquake, it is common practice when designing dams and other earth structures to reduce the design acceleration to ½ of the maximum design acceleration (Hynes and Franklin, 1984). We have calculated equivalent fluid pressures using a horizontal acceleration k_h of 0.10g (1/2 of k_h max).

Lateral pressure design parameters for variable conditions of slope, soil type, seismic conditions, and wall configurations are summarized in Table 5-1. If necessary, lateral pressures may be reduced by using imported granular material to backfill behind basement and retaining walls. The values in Table 5-1 have been calculated for the clay, sand, and gravel colluvial and residual claystone material that mantles much of Areas III, IV, and V.

For basement walls or other walls not allowed to deflect, lateral pressure design should utilize at-rest pressures (γK_o) or active seismic pressures (γK_{ae}), whichever is greater. For retaining walls or other walls allowed to deflect and develop a full active soil wedge, use active seismic pressures (γK_{ae}).

TABLE 5-1: Lateral Pressure Parameters

Condition	Coefficient of Earth Pressure*	γK (equivalent fluid pressure)+
Static Conditions		
Level Backfill	$K_o = 0.53$	61 pcf
	$K_a = 0.36$	42 pcf
	$K_p = 2.77$	319 pcf
Slope above (11°)	$K_o = 0.66$	75 pcf
	$K_a = 0.41$	47 pcf
Slope below (-11°)	$K_p = 1.99$	229 pcf
Earthquake Conditions		
Level Backfill	$K_{ae} = 0.43$	49 pcf
Slope above (11°)	$K_{ae} = 0.51$	58 pcf
Level Backfill	$K_{pe} = 2.60$	299 pcf
Slope below (-11°)	$K_{pe} = 1.80$	207 pcf

* φ equal to 28°

+ γ equal to 115 pcf

Should the site conditions for a specific site exceed the slope gradients used in the table, this office should be contacted and appropriate values should be calculated.

5.3.1 Active Pressures

For lateral pressure design of retaining walls, which are allowed to deflect and develop an active soil wedge, the calculated equivalent fluid pressure (γK_a) is about 42 pcf (pounds per cubic foot), assuming a horizontal ground surface

behind the retaining wall, or about 47 pcf for an 11-degree slope above the wall. This pressure distribution would be equivalent to a force of approximately $21H^2$ pounds per horizontal foot of wall acting at one-third the wall height (H) above the base, or $23.5H^2$ for sloping ground above the wall.

Research has indicated that lateral pressures due to earthquakes are non-hydrostatic in distribution, and the resultant acts above the lower third-point of the wall (Bakeer, et al, 1990). Accordingly, active soil pressures have been divided into two components that act at different wall heights. The static force acts at the lower third-point, as discussed above. The Mononobe-Okabe equations are often used to estimate dynamic forces against retaining walls. Although there is considerable debate about the theoretical applicability of these equations to rigid walls, they have been used for many years for seismic design and the performance record of underground walls during earthquakes has generally been good. The dynamic component of force is estimated as ½ the difference of γK_{ae} - γK_a. This force would be in addition to static active earth pressure, and is equivalent to $3.5H^2$ and $5.5H^2$ pounds (for both flat and 11-degree slopes, respectively) per horizontal foot of wall applied at 50% of the wall height above the base.

5.3.2 Passive Pressures

For passive pressure design, the earth pressure coefficient (γK_p) varies from about 319 pcf, assuming a horizontal ground surface adjacent to the wall, down to 207 pcf for a negative 11-degree slope below the wall and seismic coefficient of 0.10g.

5.3.3 At-Rest Pressures

For lateral pressure design of basement walls, which are restrained and not allowed to deflect, the calculated at rest earth pressure (γK_o) is about 61 pcf, assuming a horizontal ground surface behind the basement wall, or 75 pcf for an 11-degree slope toward the wall.

5.5 Soil Friction

Terzaghi, et al (1996) suggests use of 30 degrees for the maximum friction angle along a concrete base in granular soils. Accordingly, a friction value of 0.58, which is the tangent of 30 degrees, is suggested. The friction value may be combined with the passive pressure to resist horizontal loads.

6.0 RECOMMENDATIONS

Given that most of the investigation encountered flat-lying undisturbed bedrock, we believe that the majority of the site is stable in its current state and suitable for the proposed construction, although there is some risk that future conditions, such as a large earthquake, unusual precipitation, or manmade modifications, could initiate instability and new slope movement. The northern portion of Area III, where sheared bentonite was encountered, may require special construction techniques to key construction into coherent bedrock. It should also be noted that unfavorable foundation conditions may exist locally across Areas III, IV, and V (such as additional plastic clay or bentonite layers below the depth of the test pits) that have not been addressed in this report. Site specific geotechnical investigations should be performed to verify soil and groundwater conditions at individual building sites prior to foundation design and construction.

6.1 General Siting Recommendations

The following recommendations are provided to reduce risk of damage resulting from conditions discovered during the site investigation. The main potential problem is slope instability.

1. Where possible, new construction should avoid slopes steeper than 25°.

2. New construction should avoid mapped landslide deposits. No landslide deposits were encountered in Areas III, IV, and V.

3. Where possible in areas with shallow bedrock with bentonite beds and on thin landslide deposits, the foundation should be keyed into coherent bedrock (A structural replacement fill may be required).

6.2 Foundations

In most of the Phase 3-C Areas III, IV, and V of Cowboy Heaven, conventional shallow foundations appear to be acceptable. However, the buildings should be founded on bedrock in order to decrease the risk of slope instability. Replacement structural fills may be used in thin surface colluvial deposits and areas of shallow bedrock with bentonite beds to key foundations into bedrock. Otherwise, drilled piers or similar systems are recommended.

6.3 Site Grading and Preparation

Properly compacted backfill and good site drainage are extremely important. Structural fill should consist of imported granular fill placed in lifts no greater than 8 inches loose thickness and compacted. Compaction specifications for structural fill, exterior backfill, and utility trench backfill are presented in the following table. Existing site material may be used for exterior and utility trench backfill:

Table 6-1: Compaction Parameters

Material Type	Minimum Compaction (%)[1]	Moisture Content (%)[2]
Structural Fill	95	± 3
Exterior Backfill	90	-1 to +3
Utility Trench Backfill	90	-1 to +3

[1] Compaction specification based on percent of maximum dry density according to ASTM D-698 (standard proctor test).
[2] Moisture content specification based on percent moisture variation from the optimum moisture content (OMC) determined according to ASTM D-698.

Structural fill should be used beneath exterior slabs-on-grade or to key foundation elements into bedrock. Do not overcompact exterior backfills against "green" foundation walls. Cohesive site materials should be used in the upper 2 feet of the exterior backfill to provide a lower permeability cap.

Prior to placement of structural fill for exterior slabs-on-grade, the site should be cleared and grubbed. No brush, roots, sod, frozen material, or other deleterious or unsuitable materials shall be incorporated in the foundation subgrade or structural fill.

Final grading should provide positive drainage of at least 1 foot in the first 12 feet away from the structure. Adequate gutters are strongly recommended. Roof runoff should be discharged at least 3 feet away from the building or exterior slabs. Swales or other moisture collection points should be avoided within 20 feet of the footings.

OSHA regulations (29CFR1926) appear to classify the soil at the site as Type C based on the existence of layers that dip into potential excavations at slopes steeper than 4H:1V. Therefore, temporary cut slopes should be no steeper than 1.5H:1V for excavations less than 20 feet in height. A trench box may be used if necessary to reduce trench excavation during utility installation. The contractor shall be responsible for adherence to OSHA and other safety regulations.

6.4 Foundation Drainage

The bentonite and weathered claystone materials commonly develop perched water layers that could cause seepage into basements. For this reason, footing drains are strongly recommended. Two potential drainage alternatives are suggested, as illustrated on Figure 2.

The least expensive technique would probably be a prefabricated composite drain. The composite drain consists of an open wick layer laminated to filter fabric to reduce infiltration of soil. The exterior of the wall is waterproofed, and the drain is laid against the waterproofing layer. The excavation is backfilled with compacted site material, as discussed in section 6.2, and the drain is covered by at least 2 feet of compacted site soil, sloped to drain (minimum

8%). The composite drain is wrapped around a perforated drainpipe at footing level, at least one foot below basement floor level. Prefabricated "socks" are available to facilitate the connection. The drainpipe may slope at a minimum 0.5%, and drain to daylight or a sump. If daylighted, the pipe should be protected with a flap gate to keep out rodents. Do not place a wire screen over the end of the pipe.

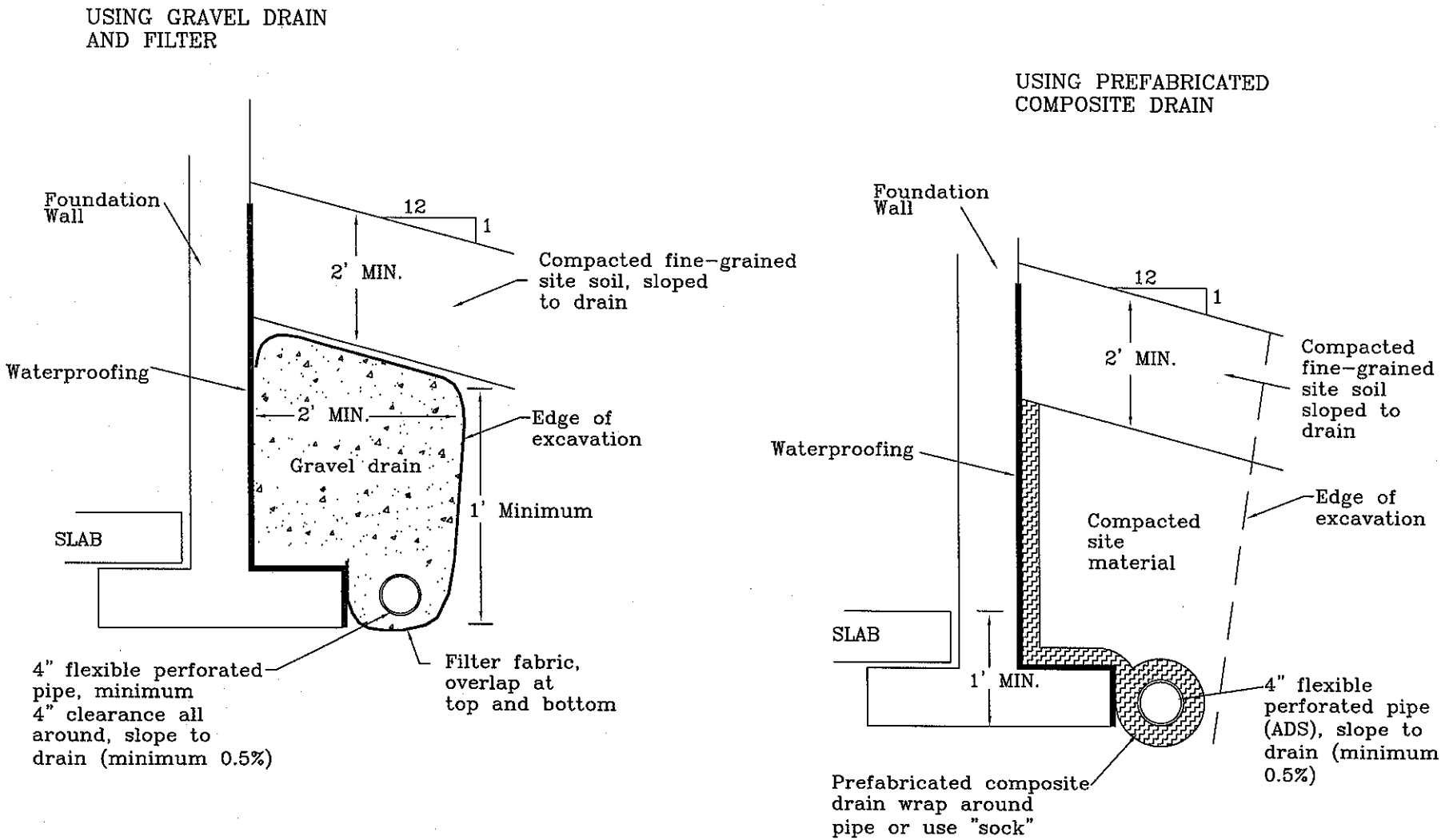
An alternative technique would involve placement of clean granular drain gravel between the foundation wall and the edge of the excavation, or between the excavation bracing and the wall. The gravel backfill is wrapped in filter fabric and a drain pipe is placed at the bottom of the trench. At least 2 feet of compacted clay backfill (sloped to drain) is placed above the gravel envelope. The gravel backfill can usually be placed without compaction, reducing backfill cost and difficulty. Also, gravel backfill may reduce the lateral stresses against the walls.

Site drainage is very important during foundation construction. Wetting of foundation soils can result in soil swell or consolidation/settlement, as well as reduction of shear strength and bearing capacity. Temporary drainage elements such as berms may be required during construction, depending on site conditions. If seepage is encountered, this office may be contacted to recommend appropriate action.

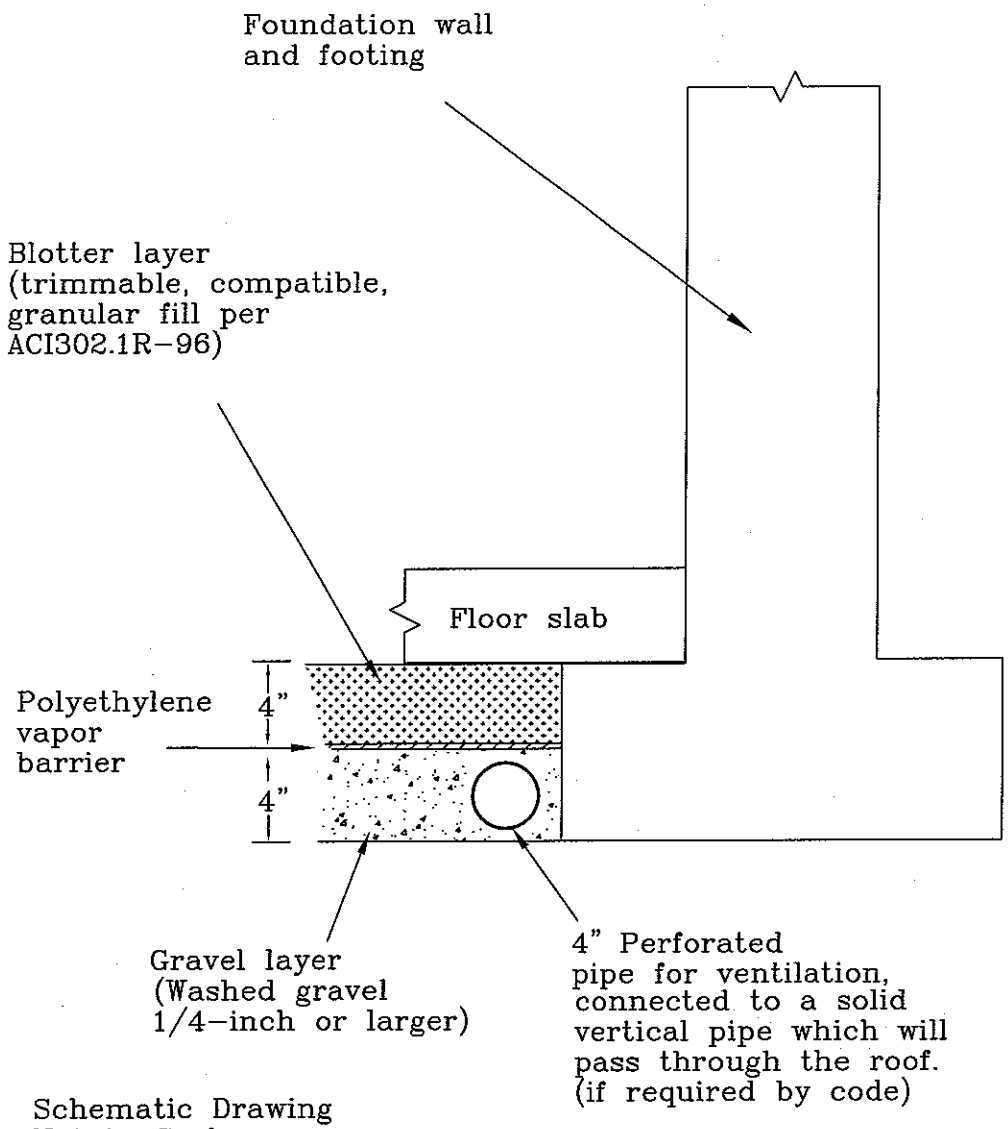
6.5 Interior Slabs-on-Grade

Interior slabs should be at least 4 inches thick, and any slabs bearing vehicles should be at least 6 inches thick. Minor floor cracking of slab-on-grade construction is difficult if not impossible to prevent. Such cracking is normal and should be expected to occur with time. Buildings are almost never free of cracks, and many factors other than soil movement, such as concrete shrinkage and daily and seasonal variability in temperature and humidity cause cracking.

An impermeable layer (usually plastic) is suggested beneath the slab, underlain by 4 inches of clean drain gravel which will act as a capillary break to reduce dampness (Figure 3). Two options are available to reduce the tendency



Preliminary Geotechnical Investigation Cowboy Heaven Phase 3-C Areas III, IV, and V Moonlight Basin, Montana	Foundation Drainage Alternatives	FIGURE 2



Schematic Drawing
Not to Scale

Preliminary Geotechnical Investigation Cowboy Heaven Phase 3-C Areas III, IV, and V Moonlight Basin, Montana	Interior Slab-on-Grade Ventilation Detail	FIGURE 3

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for the concrete to crack as it dries. Three articles from the American Concrete Institute (ACI) that discuss these options are appended.

1. A blotter layer may be placed under the slab. In the past, loose sand has been used for this purpose, but is no longer recommended. A cover of 4 inches of trimmable, compactible, granular material may be placed over the sheeting to receive the concrete slab. This material usually consists of "crusher run material", which varies in size from about 1.5-inch down to rock dust. Alternatively, 3 inches of fine graded material such as crusher fines or manufactured sand may be used.

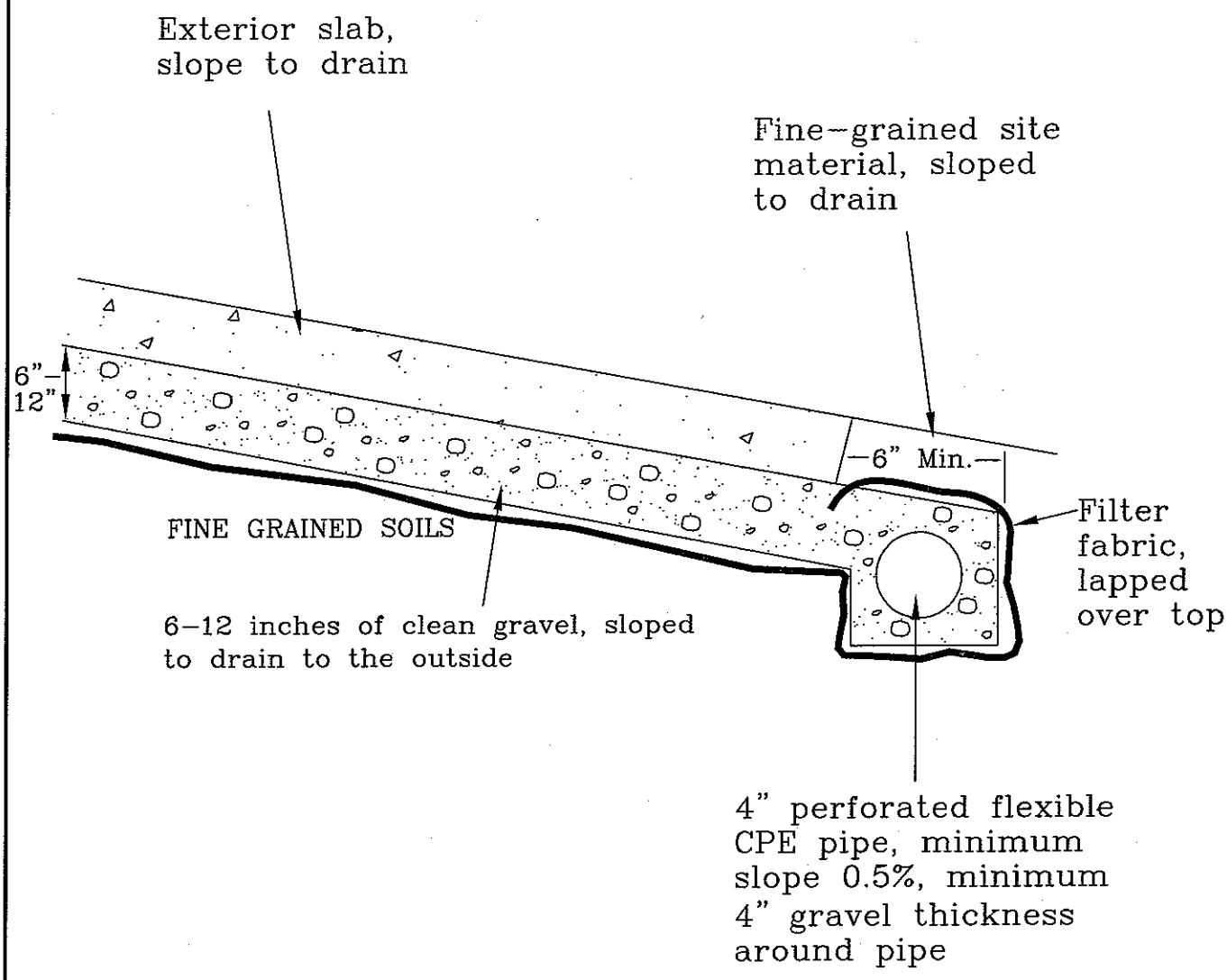
2. The blotter layer may be eliminated if the concrete is reinforced properly. The attached article entitled "Controlling Curling and Cracking in Floors to Receive Coverings" provides a discussion of proper floor slab reinforcement. If the contractor needs additional guidance on reinforcement, a structural engineer should provide it.

6.6 Exterior Slabs-on-Grade

Exterior slabs (sidewalks, driveways, etc.) have typically sustained the greatest damage in areas such as Big Sky that are subject to frost heave and high seasonal temperature and moisture variability. As is the case with interior slabs, cracking of exterior slabs is almost impossible to avoid. The following suggestions may reduce differential movement of exterior slabs or pavement. The owners and developers should be aware that prevention of frost heave involving exterior slabs or roadways may require treatment of frost-susceptible soils to the full depth of frost penetration. Local codes typically stipulate a frost depth of 42 inches. However, experience has shown that frost penetration under roadways and slabs that have no snow cover may be much greater, on the order of 60 inches or more.

Exterior slabs should be at least 4 inches thick, 6 inches if supporting vehicles. Exterior slabs should not be tied to foundation walls. Any movement of exterior slabs may be transmitted to the foundation walls, resulting in damage. Posts for patios or other exterior columns should not bear on exterior slabs. If the slabs move, the movement is transmitted to the post, resulting in damage to the structure.

Exterior slabs may be underlain by at least 6 inches, preferably 12 inches, of gravel, sloped to drain to the outside, as illustrated on Figure 4. The gravel drain layer should extend at least 2 feet outside the edge of the slab, and be covered with cohesive site material. Perforated flexible CPE drainpipe may be placed along one or more edges, depending upon final grading. The pipe may be daylighted downslope, if possible. Expansion joints are recommended in all concrete flatwork.



Schematic Drawing
Not to Scale

Preliminary Geotechnical Investigation Cowboy Heaven Phase 3-C Areas III, IV, and V Moonlight Basin, Montana	Exterior Slab-on-Grade Drainage Detail	FIGURE 4

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6.7 Ventilation and Radon

Many building codes require that slabs below living spaces be ventilated to reduce the risk of radon infiltration. Ventilation should also be provided for areas under crawl spaces. Examination of the site for potential radon levels was beyond the scope of this report. If the owner wishes to pursue this matter, we can recommend appropriate contractors.

6.8 Reinforcing, Utilities Testing, and Concrete Considerations

Footings, slabs, and foundation walls should be reinforced to resist differential movement. Consultation with a structural engineer to specify adequate reinforcement is suggested. We recommend pressure testing of water and sewer lines before backfilling. Exterior concrete should contain 5% to 7% entrained air. We strongly recommend use of sulfate-resistant concrete.

6.9 Observation during Construction

A representative of this office should observe construction of any foundation or drainage elements recommended in this report. This recommendation is extremely critical for excavation of bentonite layers and evaluation of suitable foundation conditions. Structural fill, site grading, leak-proof testing, and soil compaction should be observed by a representative of this office. If any suspicious soils or conditions are revealed during construction, this office should be notified immediately to survey the conditions and make necessary modifications.

7.0 LIMITATIONS

This report has been prepared based on a limited amount of data and is intended for single use. Data points are scattered and additional exploration is required for final design of structures. The report and accompanying figures are not to be presented separately. Actual site conditions may vary. These services have been performed in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar conditions. No other warranty is made or implied.

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APPENDIX A

TEST PIT LOGS

PROJECT: 3C Area III, Cowboy Heaven, Moonlight Basin Ranch, Big Sky, MT

TEST PIT: TP- 05-1

PIT LOCATION: 75' to edge of road

Approximate Pit Dimensions (feet): Length: 15 Width: 15 Depth: 12

Date: 6-23-05 Logged By: dpc

Approximate Surface Elevation: Log View Direction: east

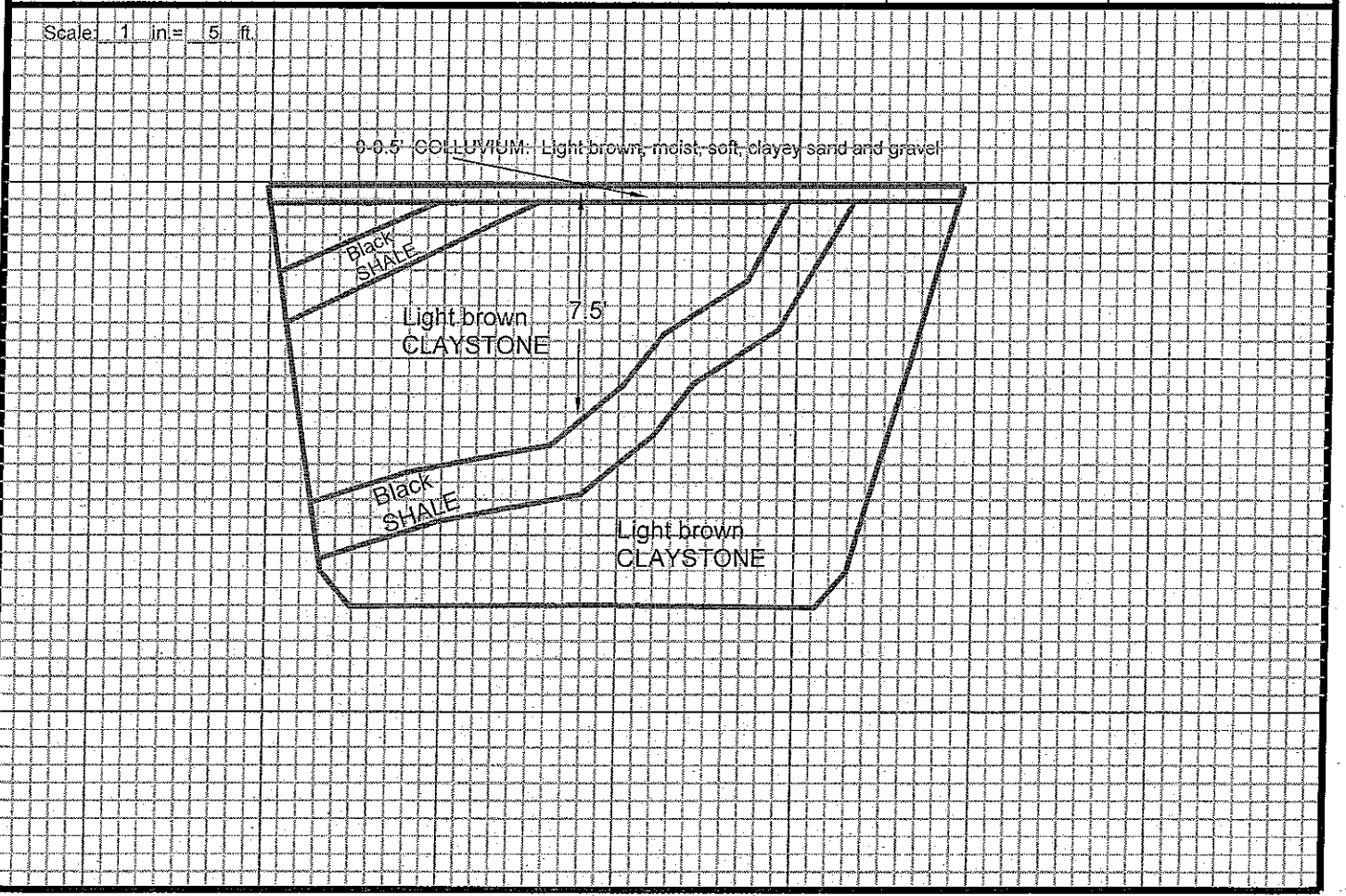
Excavation Contractor: Moonlight Basin Ranch Equipment: Hitachi UH07

WOMACK AND ASSOCIATES, INC.
• Geotechnical Engineering • Geology
P.O. Box 12650, Jackson, Wyoming 83002
(307) 733-7209 FAX (307) 733-9005

MATERIAL DESCRIPTIONS	ORIENTATIONS	SAMPLES

Note: Soil Classifications (USCS) based on field descriptions

Scale: 1 in = 5 ft



PROJECT: 3C Area III, Cowboy Heaven, Moonlight Basin Ranch, Big Sky, MT

TEST PIT: TP- 05-2

PIT LOCATION: See site map

Approximate Pit Dimensions (feet): Length: 20 Width: 15 Depth: 10

Date: 6-23-05 Logged By: dpc

Approximate Surface Elevation: Log View Direction: Toward Lone Peak

Excavation Contractor: Moonlight Basin Ranch Equipment: Hitachi UH07

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MATERIAL DESCRIPTIONS

0-0.5 TOPSOIL: Moist, black, soft, slightly plastic, with shale sand and gravel;

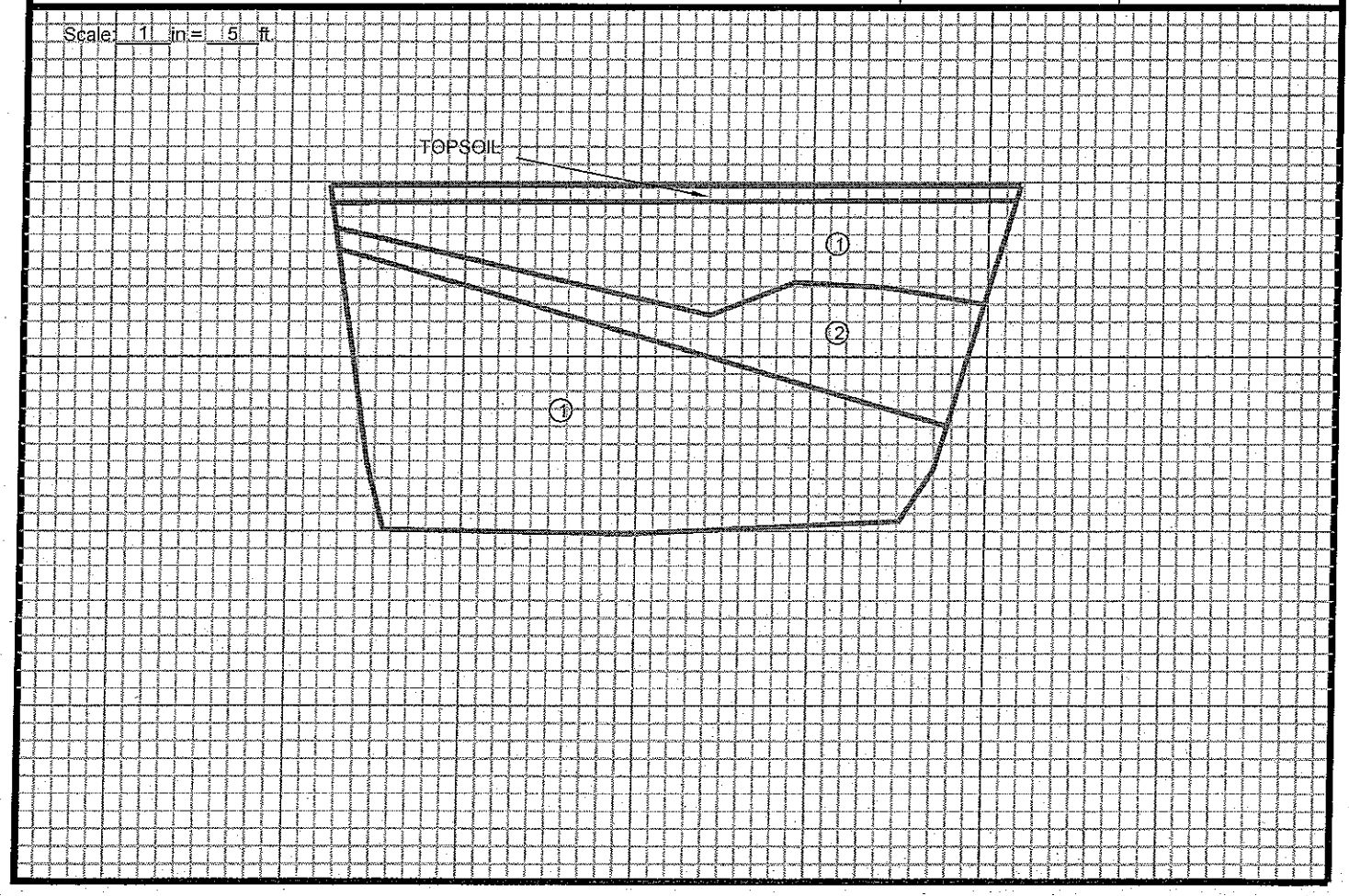
① SHALE BEDROCK: Slightly moist, weak, weathered, highly fractured, 0.5 - 3" spacing

② BENTONITE: Slightly moist, light brown, weathered CLAYSTONE, highly plastic, with very weak weathered claystone, highly fractured, appears to be sheared from folding

ORIENTATIONS

SAMPLES

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: 3C Area VI, Cowboy Heaven, Moonlight Basin Ranch, Big Sky, MT

TEST PIT: TP- 05-3

PIT LOCATION: See site map

Approximate Pit Dimensions (feet): Length: 20 Width: 15 Depth: 8

Date: 6-23-05 Logged By: dpc

Approximate Surface Elevation: Log View Direction: South

Excavation Contractor: Moonlight Basin Ranch Equipment: Hitachi UH07

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(307) 733-7209 FAX (307) 733-8005

MATERIAL DESCRIPTIONS

0-0.5 TOPSOIL: Moist, black, soft, slightly plastic, with shale sand and gravel;

① 0.5-2.5 COLLUVIUM: Moist, brown, soft, plastic CLAY, with sand and gravel

② 2.5-5.0 CLAYSTONE: Moist, light brown, weathered claystone, some sandstone layers, with clayey soft matrix

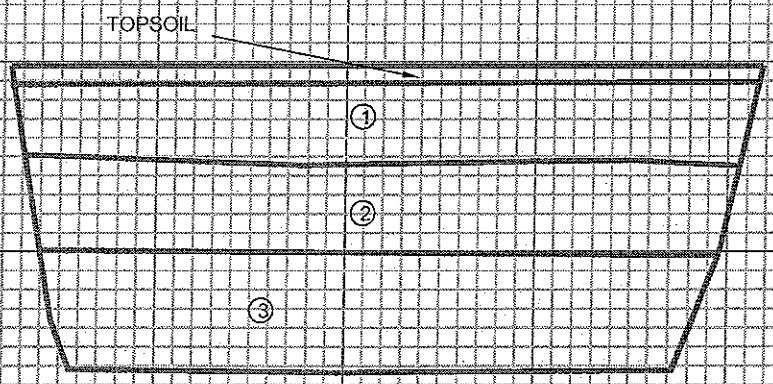
③ 5.0-8.0 SANDSTONE: Black, tan

ORIENTATIONS

SAMPLES

Note: Soil Classifications (USCS) based on field descriptions

Scale: 1 in = 5 ft



PROJECT: 3C Area VI, Cowboy Heaven, Moonlight Basin Ranch, Big Sky, MT

TEST PIT: TP- 05-4

PIT LOCATION: See site map

Approximate Pit Dimensions (feet): Length: 20 Width: 15 Depth: 8

Date: 6-23-05 Logged By: dpc

Approximate Surface Elevation: Log View Direction: South

Excavation Contractor: Moonlight Basin Ranch Equipment: Hitachi UH07

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P.O. Box 12650, Jackson, Wyoming 83002
(307) 733-7209 FAX (307) 733-8005

MATERIAL DESCRIPTIONS

0-0.5 TOPSOIL: Moist, black, soft, plastic, with sand and gravel;

① 0.5-3.0 WEATHERED CLAYSTONE: Moist, orange/brown, soft, plastic CLAY, with some sand and gravel to 3" diameter

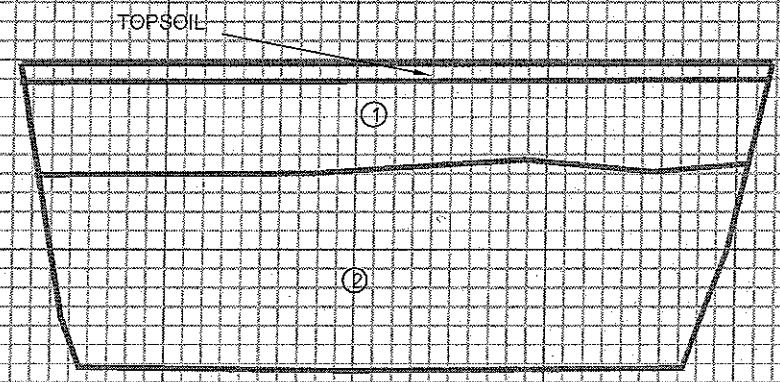
② 3.0-8.0 SANDSTONE BEDROCK: Moist, medium brown, angular, strong, jointed, 10" maximum, with sandy clay matrix, nearly horizontally bedded

ORIENTATIONS

SAMPLES

Note: Soil Classifications (USCS) based on field descriptions

Scale: 1 in.= 5 ft.



PROJECT: 3C Area VI, Cowboy Heaven, Moonlight Basin Ranch, Big Sky, MT

TEST PIT: TP- 05-5

PIT LOCATION: See site map

Approximate Pit Dimensions (feet): Length: 20 Width: 15 Depth: 8

Date: 6-23-05 Logged By: dpc

Approximate Surface Elevation: Log View Direction: South

Excavation Contractor: Moonlight Basin Ranch Equipment: Hitachi UH07

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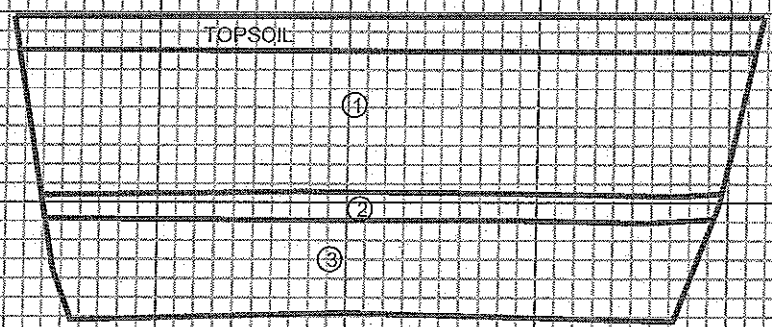
MATERIAL DESCRIPTIONS	ORIENTATIONS	SAMPLES
0-1.0 TOPSOIL: Moist, black, soft, SILT, organics, roots		
① 1.0-4.8 RESIDUAL CLAYSTONE: Light tan, weathered, soft to firm, CLAY	2-2.5 TSF	
② 4.8-5.4 SANDSTONE BEDROCK: Red brown, very strong, 2-6" joints, layered 1-2"		
③ 5.4-7.9 SANDSTONE BEDROCK: Medium brown, weak, 2-4" bedding, 6-8" joints		

Note: Soil Classifications (USCS) based on field descriptions

Scale: 1 in = 5 ft



APPENDIX B

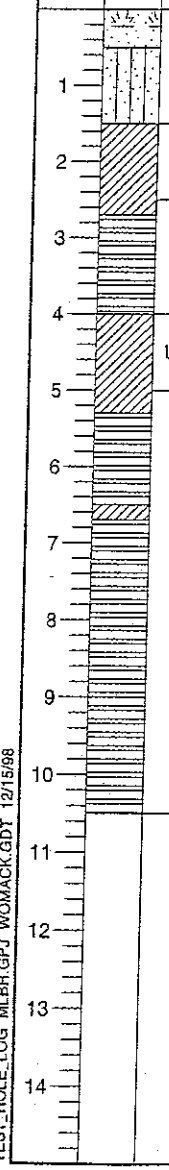
BOREHOLE AND TEST PIT LOGS
FROM PREVIOUS INVESTIGATIONS

WOMACK & ASSOCIATES, INC.
Geotechnical Engineering
Geology

5825 Lazy Lane
Billings, MT 59106
Telephone: (406) 656-5398
Fax: (406) 656-8912

TEST HOLE LOG

PROJECT: Moonlight Basin Ranch	HOLE NO.: TP-98-1	DATE: 10-16-98
TEST HOLE LOCATION: West portion of Area 2, along main road		
ELEVATION G.S.:	TOTAL DEPTH: 10.5	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Case extendahoe	DRILLER: Clayton	LOGGED BY: GSV



DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
0-1							0.0-0.5' Sandy SILT: Dark brown, dry to moist, loose, roots [Topsoil] 0.5-1.5' Sandy SILT with gravel: Dark to medium brown, dry to slightly moist, loose, structureless, about 30% angular platy shale gravel 1/2" to 3", and cobbles to 6" [Colluvium]					
1-2		U1			1.0-1.25		1.5-2.7' CLAY: Brown to tan, slightly moist to moist, stiff, highly plastic, massive [Bentonite/Residual Bedrock]					
2-3							2.7-4.0' SHALE: Dark brown, dry, very thinly bedded to laminated, deeply weathered, hard, fraible, orientation 30°/10° west					
3-4												
4-5		U2			1.5-1.75		4.0-5.3' BENTONITE: Light olive yellow, slightly moist, stiff, highly plastic, massive					
5-6							5.3-6.5' SHALE: Dark brown to black, dry, very thinly to thinly bedded, deeply weathered, hard, friable [Thermopolis Fm]					
6-7							6.5-6.7' BENTONITIC SHALE: Light yellowish brown, dry, very thinly bedded, weak, very low hardness 6.7-10.5' SHALE: Dark brown to black, dry, very thinly to thinly bedded, deeply weathered, hard, friable [Thermopolis Fm] Thin bentonitic shale layers 0.2' thick at about 8' and 9.5'					
7-8												
8-9												
9-10												
10-11												
11-12												
12-13												
13-14												

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TEST HOLE LOG

PROJECT: Moonlight Basin Ranch	HOLE NO.: TP-98-2	DATE: 10-16-98
TEST HOLE LOCATION: South central portion of Area 2, ~50' north of road, ~225' west of powerline		
ELEVATION G.S.:	TOTAL DEPTH: 13	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Case extendahoe	DRILLER: Clayton	LOGGED BY: GSV

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.0' Silty CLAY: Very dark brown to black, moist, soft, roots, organics [Topsoil]					
2		U1			1.0		1.0-5.7' Silty CLAY: Dark brown to dark grayish brown (mottled), moist, medium stiff to stiff, massive to some stratification of 2" to 3" shale gravel layers [Colluvium]					
3		U2			2.0							
4												
5												
6							5.7-9.2' SHALE: Dark gray, slightly moist to wet at contact with colluvium, very thinly bedded to laminated, deeply weathered, fraible, low hardness, bedding appears to be 20° /10° west [Thermopolis Fm] Note: Bedding at shale/sandstone contact appears to be oriented more east-west with shallow dip to N (~5°)					
7												
8												
9												
10							9.2-13.0' Clayey to silty SANDSTONE: Light yellowish brown, slightly moist to moist, thinly bedded, moderately to deeply weathered, very low hardness, friable [Thermopolis Fm]					
11		3										
12												
13												
14												

TEST_HOLE_LOG MLBR.GPJ WOMACK.GDT 12/15/98

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Fax: (406) 656-8912

TEST HOLE LOG

PROJECT: Moonlight Basin Ranch	HOLE NO.: TP-98-3	DATE: 10-16-98
TEST HOLE LOCATION: Area 2, north central Section 24, ~80-100' north of road, 150' south of powerline		
ELEVATION G.S.:	TOTAL DEPTH: 12.5	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Case extendahoe	DRILLER: Clayton	LOGGED BY: GSV

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.0' Clayey SILT: Very dark brown to black, moist, soft, roots, organic debris [Topsoil]					
2							1.0-4.5' Silty CLAY with some sand and gravel: Light brown, moist, medium stiff to stiff, curde stratification subparallel to slope, some roots and organic debris, about 70% plastic fines, 30% fine to coarse grained sand and angular shale and sandstone gravel to 3", scattered cobbles to 8" [Colluvium]					
3												
4												
5							4.5-12.5' SHALE: Very dark brownish gray, slightly moist to moist, very thinly bedded to laminated, deeply weathered, low hardness, friable, highly fractured, bedding 80°/14° N and 60°/11° N [Thermopolis Fm]					
6												
7							Rock strength and hardness vary from friable low hardness to moderately strong, moderately hard					
8												
9												
10												
11												
12												
13												
14												

TEST_HOLE_LOG MLBR.GPJ WOMACK.GDT 12/15/98

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Geotechnical Engineering
Geology

5825 Lazy Lane
Billings, MT 59106
Telephone: (406) 656-5398
Fax: (406) 656-8912

TEST HOLE LOG

PROJECT: Moonlight Basin Ranch	HOLE NO.: TP-98-4	DATE: 10-16-98
TEST HOLE LOCATION: Area 2 north central Section 24, ~450' west of TP-3, above obvious landslide scarp		
ELEVATION G.S.:	TOTAL DEPTH: 13.5	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Case extendahoe	DRILLER: Clayton	LOGGED BY: GSV

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.5' Sandy SILT: Dark brown, moist, loose, roots [Topsoil/Reworked Fill]					
2							1.5-6.5' Sandy CLAY with gravel and cobbles: Dark brown, slightly moist to moist, stiff to very stiff, massive, about 60% plastic fines, about 20% fine to coarse grained sand, and 20% angular to subrounded gravel and cobbles consisting of mostly sandstone, some andesite and few shale [Glacial Till or Colluvium]					
3												
4												
5		1										
6												
7							6.5-13.5' Sandstone COBBLES with silty to clayey sand matrix: Clast supported, dark yellowish brown, moist, dense, structureless, about 80% hard sandstone cobbles to 12", 20% fine grained sand and fines.					
8							At 9.0' increase in moisture, pockets of water and increase in clay content in matrix, some subrounded gravel					
9							At 11.0' very hard sandstone cobbles, difficult digging					
10							Uncertain of soil origin, predominantly sandstone cobbles, clast supported, no visible bed forms or layering, probably landslide debris					
11							[Colluvium or Landslide Debris]					
12												
13												
14												

TEST_HOLE_LOG MLBR.GPJ WOMACK.GDT 12/15/98

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Geology

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Fax: (406) 656-8912

TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-1
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8295	TOTAL DEPTH: 12.7	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
0							0.0-0.2' SOD 0.2-0.8' Clayey SAND - moist, orange, medium dense, scattered angular to subrounded gravels, roots [TOPSOIL] 0.8-8.4' GRAVEL and COBBLES - angular to subrounded andesite, up to 6-inch diameter, in a matrix of very moist, orange, loose to medium dense, clayey sand [SCREE]					
8							8.4-10.3' GRAVEL - angular to subrounded andesite, up to 3-inch diameter, in a matrix of wet, dark gray to greenish brown, loose, with minor clayey sand infilling, many voids [SCREE]					
10		D1				SM	10.3-10.7' Silty SAND - wet, grayish brown to pale gray, loose, intact, numerous gravels and roots, lenticular patches of organics [PALEOSOL]	21.1		NP	NP	
11		D2					10.7-12.3' GRAVEL - angular to subrounded andesite, up to 2-inch diameter, occasional cobbles, in a wet, loose, clayey sand, thin layer of stiff, orange, gravelly, plastic clay at the top [TILL]					
12		D3				GC	12.3-12.7' WEATHERED ANDESITE - moist, plastic, very stiff, clayey GRAVEL with angular very weak, andesite cobbles - fractured, weathered rock with clay in the fractures [BEDROCK]	8.7		30	15	
13												
14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-2
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8284	TOTAL DEPTH: 10.4	GROUNDWATER LEVEL: perched @ 4.5'	MEASURED FROM: ground surface
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–4							0.0-0.2' SOD 0.2-0.6' Clayey SAND - moist, orange, medium dense, scattered, angular to subrounded gravels, roots [TOPSOIL] 0.6-4.5' GRAVEL and COBBLES - angular to subrounded andesite, in a matrix of moist, yellow brown, clayey, coarse-grained sand (60% Gravels) [LANDSLIDE DEBRIS]					
4–5		U1 U2			0.6	CH	4.5-4.6' CLAY - very moist, reddish brown, firm, plastic, slickensided [SHEAR ZONE] (shear zone dip ~10 degrees, dip direction ~ N47E) Isolated seepage along top in gully 4.6-7.1' DISTURBED SHALE - dark gray to grayish brown, very weak, highly fractured, distorted [LANDSLIDE DEBRIS]	27.3	96.2	55	37	
7–8		U3 U4			1.6	CH	7.1-7.4' CLAY - moist, pale gray to yellowish orange, stiff, plastic, slickensided [SHEAR ZONE] (shear zone dip ~12 degrees east, strike N25W) 7.4-10.4' SHALE - black, very weak, laminated, sheared with slickensides, bedding somewhat distorted and irregular, but apparently in place [BEDROCK] Perched water at ~8' Bedding orientation ~ due north; 30 degrees east	26.5	88.4	58	33	
11–14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-3
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8280	TOTAL DEPTH: 18.5	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-0.3' SOD 0.3-1.3' Sandy CLAY - moist, yellowish brown, soft, intact, numerous gravels and roots [TOPSOIL]					
2							1.3-8.7' Clayey SAND - moist, yellowish brown, medium dense, intact, coarse to fine-grained, with numerous rounded to subrounded gravels, occasional andesite cobbles [COLLUVIUM]					
3												
4												
5												
6												
7												
8												
9							8.7-18.5' GRAVEL and COBBLES - subangular to subrounded andesite, up to 6-inch diameter, in a matrix of moist, yellowish brown, stiff, sandy Clay [TILL]					
10												
11												
12												
13												
14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch | DATE: 6/28/99

PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana | HOLE NO.: TP-99-3

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												
32												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-4
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8300	TOTAL DEPTH: 7	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1					3.0		0.0-0.3' SOD 0.3-2.5' Sandy CLAY - moist to very moist with depth, yellowish brown, stiff, intact, roots [TOPSOIL]					
2												
3					2.8		2.5-4.2' RESIDUAL ANDESITE - moist, pale yellowish gray, stiff, intact, plastic, slightly sandy CLAY, roots, possible shearing at base [BEDROCK]					
4												
5							4.2-7.0' ANDESITE - dark greenish gray, weak, highly fractured, banding ~1-inch thickness to very thin bedded near 4.9-foot depth [BEDROCK] Banding thickness about 2 to 6-inches Banding orientation (dip) - 8 degrees northeast					
6												
7												
8												
9												
10												
11												
12												
13												
14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-5
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8265	TOTAL DEPTH: 14	GROUNDWATER LEVEL: NA	MEASURED FROM:
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-4.2' Sandy CLAY - moist, pale yellowish brown, stiff, intact, scattered gravels and cobbles, roots [TOPSOIL]					
2												
3												
4												
5							4.2-7.8' Deformed SHALE - black to yellowish brown, laminated, highly deformed, very weak, slid into place [LANDSLIDE DEBRIS]					
6												
7												
8		D1			0.9	CH	7.8-9.5' CLAY - very moist to wet, yellowish brown, firm, microshattered, plastic, abundant shale and andesite fragments [GOUGE -SHEAR ZONE]	23.3		59	38	
9							Orientation of shear zone - 37 degrees downslope					
10							9.5-14.0' ANDESITE - dark greenish brown, weak, randomly and very highly fractured, with irregular rubblized zone at the top and some internal shearing down to about 12.5'					
11												
12							Bedding orientation (dip) - 8 degrees northeast					
13												
14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-6
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8315	TOTAL DEPTH: 10.5	GROUNDWATER LEVEL: slow seepage @ 9'	MEASURED FROM: ground surface
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-0.5' SOD					
							0.5-3.0' Sandy CLAY - moist, pale yellowish brown, firm, intact, occasional gravels, roots [TOPSOIL]					
2					1.0							
3					0.6		3.0-3.8' Sandy CLAY - very moist, dark grayish brown, firm, intact, roots and scattered gravels [LANDSLIDE DEBRIS]					
4							3.8-4.8' CLAY - moist, dark yellowish brown, stiff, with numerous shale fragments [LANDSLIDE DEBRIS] Below 4.3' clay is wet, black, very soft					
5					3.1		Shear zone at 4.6'					
6							4.8-5.8' CLAY - very moist, dark gray to yellowish brown, stiff, microshattered, plastic, with shale fragments [GOUGE]					
7					2.5		5.8-8.4' CLAY and SHALE fragments - moist, yellowish brown, stiff, thinly laminated [GOUGE]					
8		D1				CL		20.0		48	28	
9							8.4-10.5' ANDESITE - greenish gray, very weak, thinly banded [BEDROCK]					
10							Banding orientation - north 10 degrees east, 24 degrees east					
11												
12												
13												
14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-7
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8285	TOTAL DEPTH: 7.6	GROUNDWATER LEVEL: 7.5	MEASURED FROM: ground surface
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
0							0.0-0.4' SOD					
1							0.4-0.7' Clayey SAND - wet, pale-yellowish brown, very loose, intact, scattered angular andesite gravels and boulders, roots [TOPSOIL]					
2							0.7-4.6' CLAY - moist, pale yellowish brown, firm, plastic, shear zone probably at base [GOUGE/LANDSLIDE DEBRIS]					
3												
4		D1			1.0	CH		19.6		53	34	
5							4.6-7.6' ANDESITE - dark gray, randomly and highly fractured, with minor clay along fractures [BEDROCK]					
6												
7												
8												
9												
10												
11												
12												
13												
14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 6/28/99
PROJECT LOCATION: Cowboy Heaven Cabins, Big Sky, Montana	HOLE NO.: TP-99-8
TEST HOLE LOCATION: See location map in report	

ELEVATION G.S.: ~8275	TOTAL DEPTH: 11.5	GROUNDWATER LEVEL: 11.3	MEASURED FROM: ground surface
DRILL TYPE: Trackhoe	HAMMER:	DRILL CO: MBR	DRILLER: Shad	LOGGED BY: wrw

DEPTH (FT.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–5							0.0-1.1' Sandy CLAY - moist, yellowish brown, firm, fissured, scattered gravels, roots [TOPSOIL] 1.1-5.0' BOULDERS - composed of Siltstone, black shale debris near surface [RUBBLE/LANDSLIDE DEBRIS]					
5–6		U1 U2			1.3	CH	5.0-6.6' CLAY - very moist, yellowish brown, firm, plastic [GOUGE] Orientation (dip) of gouge - 31 degrees northeast	27.3	95.5	68	46	
7–11					1.0		6.6-7.0' SHALE fragments - very moist, yellow, stiff, in a matrix of plastic clay [GOUGE] 7.0-9.8' SHALE - yellowish brown, very weak, laminated [LANDSLIDE DEBRIS] Orientation - north 5 degrees east, 28 degrees east ~9.6-9.8' CLAY - very moist, yellowish over maroon, firm, plastic [BEDROCK/SHEAR CONTACT] 9.8-11.5' ANDESITE - greenish gray, moderately strong, randomly and moderately fractured [BEDROCK]					
12–14												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-1
TEST HOLE LOCATION: Upper access road, 150' northeast from junction	

ELEVATION G.S. (Ft.): 8164	TOTAL DEPTH (Ft.): 17	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–19		TP1-1 @ 12'					0.0-12.0' GRAVEL and COBBLES with a clayey sand matrix: Light reddish brown, moist, medium dense, massive, about 30-40% angular andesite cobbles to 8", 30-40% subangular to angular gravel to 3", 20% fine to coarse grained sand, 10-15% plastic clay [GLACIAL DEPOSITS] 12.0-15.0' Sandy CLAY with gravel: Light reddish to yellowish brown, moist, stiff, plastic, lmassive, about 50-60% clay, 20-25% fine to coarse grained sand, 20-25% gravel to 1" 15.0-17.0' GRAVEL and COBBLES: As above, increase in large cobbles near base					

PROJECT: Moonlight Basin Ranch Cowboy Heaven Phase 2, Big Sky, MT

TEST PIT: TP- 01-2

PIT LOCATION: east side upper access road, ~300' NE of junction

Approximate Pit Dimensions (feet): Length: 17 Width: 6 Depth: 13

Date: 7-9-01 Logged By: gsv

Approximate Surface Elevation: 8150' Log View Direction: north

Excavation Contractor: MBR Equipment: Kobelco sk150lc

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MATERIAL DESCRIPTIONS

① 0' - 3' (varies): Gravel and Cobbles with a sandy clay matrix; brown, very moist, loose, massive [road fill and colluvium]

② 3' - 13' (varies): SHALE with siltstone interbeds; very dark grayish brown, moist, hard, blocky fracture [Albino, Muddy, and Thermopolis Fm. Undif.]

③ 3' - 8': BENTONITIC CLAY; light gray to white, slightly moist to moist, medium stiff to stiff, massive to laminated [Albino, Muddy, and Thermopolis Fm. Undif.]

*appears to be in place bedrock, strata is dipping steeper than the surface slope, no indication of slope movement

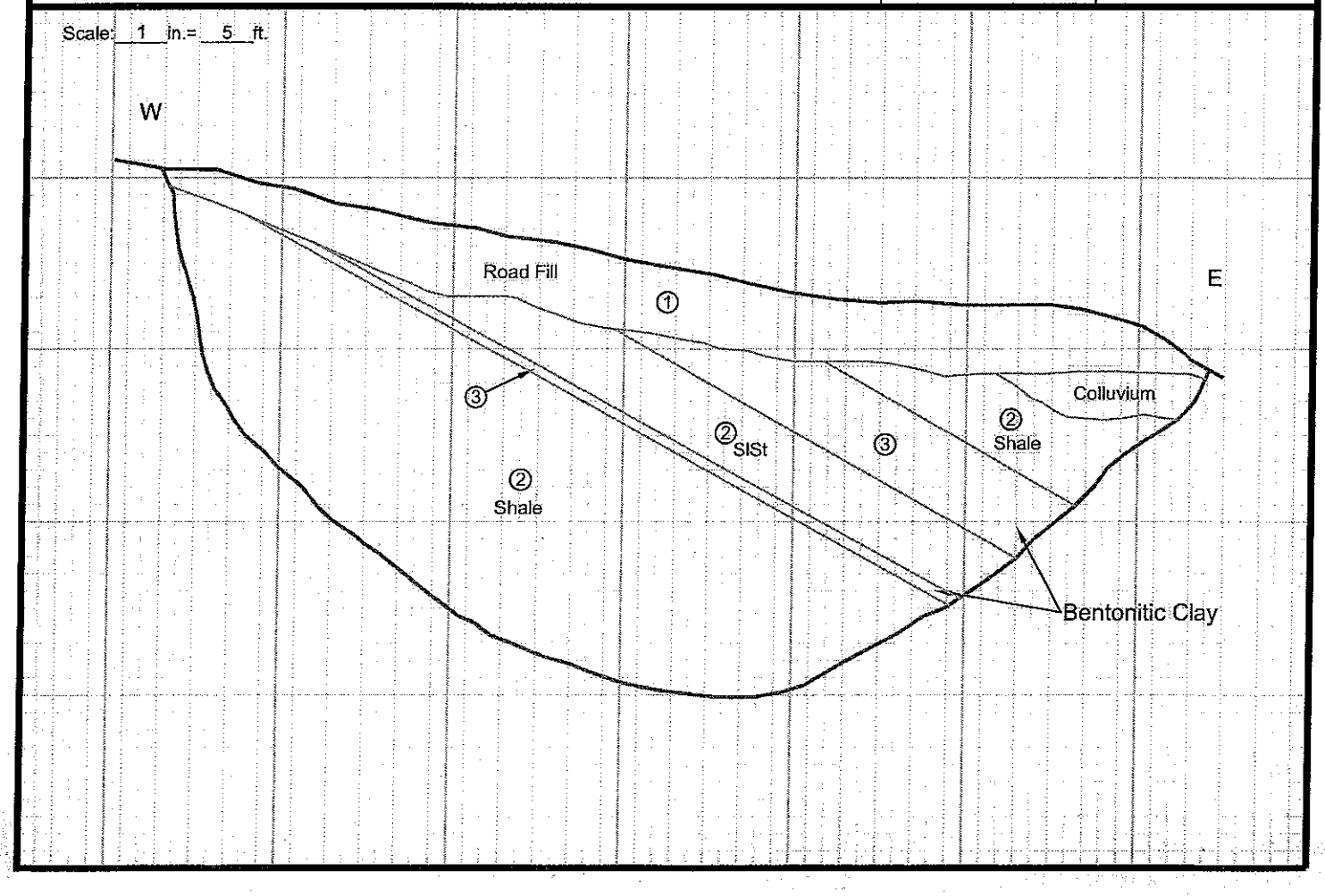
ORIENTATIONS

Siltstone
165 deg/43 deg NE

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-3
TEST HOLE LOCATION: Phase 2 cabins, below existing cabin #16	

ELEVATION G.S. (Ft.): 8180	TOTAL DEPTH (Ft.): 13	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–13							0.0-0.5' Sandy SILT: Dark brown, dry to slightly moist, loose, massive, organic debris, scattered gravel [TOPSOIL] 0.5-13.0' GRAVEL and COBBLES with clayey sand matrix: Light reddish brown, slightly moist to moist, loose to medium dense, massive, about 50-60% subangular to angular gravel and cobbles to 8", 30% fine to coarse grained sand, 10-20% plastic fines [GLACIAL DEPOSITS] Note: Pit wall collapsing in upper 6'					

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-4
TEST HOLE LOCATION: Phase 2 cabins, central portion	

ELEVATION G.S. (Ft.): 8190	TOTAL DEPTH (Ft.): 14	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19		TP4-					0.0-0.5' Sandy SILT: Dark brown, dry to slightly moist, loose, massive, organic debris, scattered gravel [TOPSOIL] 0.5-14.0' GRAVEL and COBBLES with clayey sand matrix: Light reddish brown, slightly moist to moist, loose to medium dense, massive, about 50-60% subangular to angular gravel and cobbles to 8", 30% fine to coarse grained sand, 10-20% plastic fines [GLACIAL DEPOSITS]					

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-5
TEST HOLE LOCATION: Phase 2 cabins, west portion, near road switchback	

ELEVATION G.S. (Ft.): 8220	TOTAL DEPTH (Ft.): 14	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–14							0.0-0.5' Sandy SILT with gravel: Dark brown, dry to slightly moist, very loose, roots and organic debris [TOPSOIL] 0.5-14.0' GRAVEL and COBBLES with a silty sand matrix: Yellowish to reddish brown, moist, loose to medium dense, crude stratification in 1' to 3' layers, 60-70% angular andesite gravel and cobbles to 10", 20-30% fine to coarse grained sand, 10-20% non plastic fines [GLACIAL/TALUS] Note: Boulder layer at 10-12', andesite and purple SANDSTONE boulders to 1.5'					

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-6
TEST HOLE LOCATION: Phase 2 cabins, west end of upper switchback	

ELEVATION G.S. (Ft.): 8196	TOTAL DEPTH (Ft.): 10	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.0' Sandy SILT: Light brown, slightly moist, loose [TOPSOIL]					
2							1.0-3.5' Clayey GRAVEL: Grayish to reddish brown, moist, medium stiff, massive [COLLUVIUM]					
3												
4							3.5-10.0' Interbedded fine sandstone, siltstone and shale: 1" to 1' layers, hard, medium strong to strong, block fracture with clay infillings, bedding orientation 150°/26° NE [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
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TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-7
TEST HOLE LOCATION: Ridge ~250' west of upper switchback	

ELEVATION G.S. (Ft.): 8216	TOTAL DEPTH (Ft.): 10	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–10							0.0-0.5' Sandy to clayey SILT [TOPSOIL] 0.5-2.0' Bentonitic CLAY: (Depth varies from 0' on east end, 2.0' on west end), yellowish brown, slightly moist, stiff 2.0-10.0' SHALE: Grayish to dark brown, moist, weak to moderately strong, friable to blocky fracture, thinly bedded Note: Appears to be inplace bedrock. Difficult to get bedding orientation because rock is highly fractured. Bedding orientation approximately 120-130° / 30° NE [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-8
TEST HOLE LOCATION: About 450' west of upper switchback	

ELEVATION G.S. (Ft.):	TOTAL DEPTH (Ft.): 8	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-0.5' Sandy SILT: [TOPSOIL]					
2							0.5-2.5' Silty fine SAND: Light brown, slightly moist, loose, massive, scattered platy sandstone gravel [COLLUVIUM]					
3							2.5-8.0' SANDSTONE: Very fine to fine grained, light grayish brown, slightly moist, moderately strong, thinly bedded, closely fractured Note: Intact bedrock, bedding orientation 150° / 33° NE, 148° / 25° NE [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-9-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-9
TEST HOLE LOCATION: Northwest of switchback, west of southwest corner of Lot #1	

ELEVATION G.S. (Ft.): 8132	TOTAL DEPTH (Ft.): 17	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: Kobelco SK150LC	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–7							0.0-0.3' Sandy SILT: [TOPSOIL] 0.3-7.5' Broken SHALE and some sandstone with clayey sand matrix: Light brown and gray mixed, moist, very loose (pit walls collapsing), randomly oriented rock fragments [LANDSLIDE DEBRIS]					
8							7.5-8.5' Gravelly CLAY: Bentonitic, light gray to yellowish white, [possible upper shear zone 105°/20° N]					
9–10							8.5-10.5' SHALE: Very dark gray, very moist to wet along fractures, weak, blocky fracture [LANDSLIDE DEBRIS]					
11–15							10.5-15.0' Clayey GRAVEL: Light brownish gray, moist to very moist, very loose to loose, angular shale clasts [LANDSLIDE DEBRIS]					
15–17							15.0-17.0' BENTONITE: Light gray to white, moist, soft to stiff, (0.75-1.5 tsf) below 17', [possible lower shear zone] Note: Excavator limit at 17', very dangerous pit did not enter to log					
18–19												

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

PROJECT: Moonlight Basin Ranch Cowboy Heaven Phase 2, Big Sky, MT

TEST PIT: TP- 01-10

PIT LOCATION: W. of switchback ~150', edge of tree line along ski trail

Approximate Pit Dimensions (feet): Length: 20 Width: 8 Depth: 16.5

Date: 7-10-01 Logged By: gsv

Approximate Surface Elevation: 8152' Log View Direction: north

Excavation Contractor: MBR Equipment: CAT 318B Excavator

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MATERIAL DESCRIPTIONS

① 0' - 0.3': Sandy SILT [Topsoil]

② 0.3' - 5' (varies): CLAYSTONE; gray, slightly moist, very weak, highly weathered [Albino, Muddy, and Thermopolis Fm. Undif.]

③ 1' - 7' (varies): SHALE; very dark brown, weak friable, very closely fractured [Albino, Muddy, and Thermopolis Fm. Undif.]

④ 3' - 10' (varies): BENTONITIC SHALE; light gray brown, slightly moist, very stiff, plastic, massive [Albino, Muddy, and Thermopolis Fm. Undif.]

⑤ 5.5' - 16' (varies): SHALE; brown, dry to slightly moist, moderately hard, moderately strong, blocky, very close fractures [Albino, Muddy, and Thermopolis Fm. Undif.]

⑥ 13.5' - 16.5' (varies): BENTONITE; light brownish yellow, slightly moist, stiff [Albino, Muddy, and Thermopolis Fm. Undif.]

*bedding is continuous - appears to be in place bedrock, but dip slope conditions (i.e., bedding inclined parallel to slope)

Note: Soil Classifications (USCS) based on field descriptions

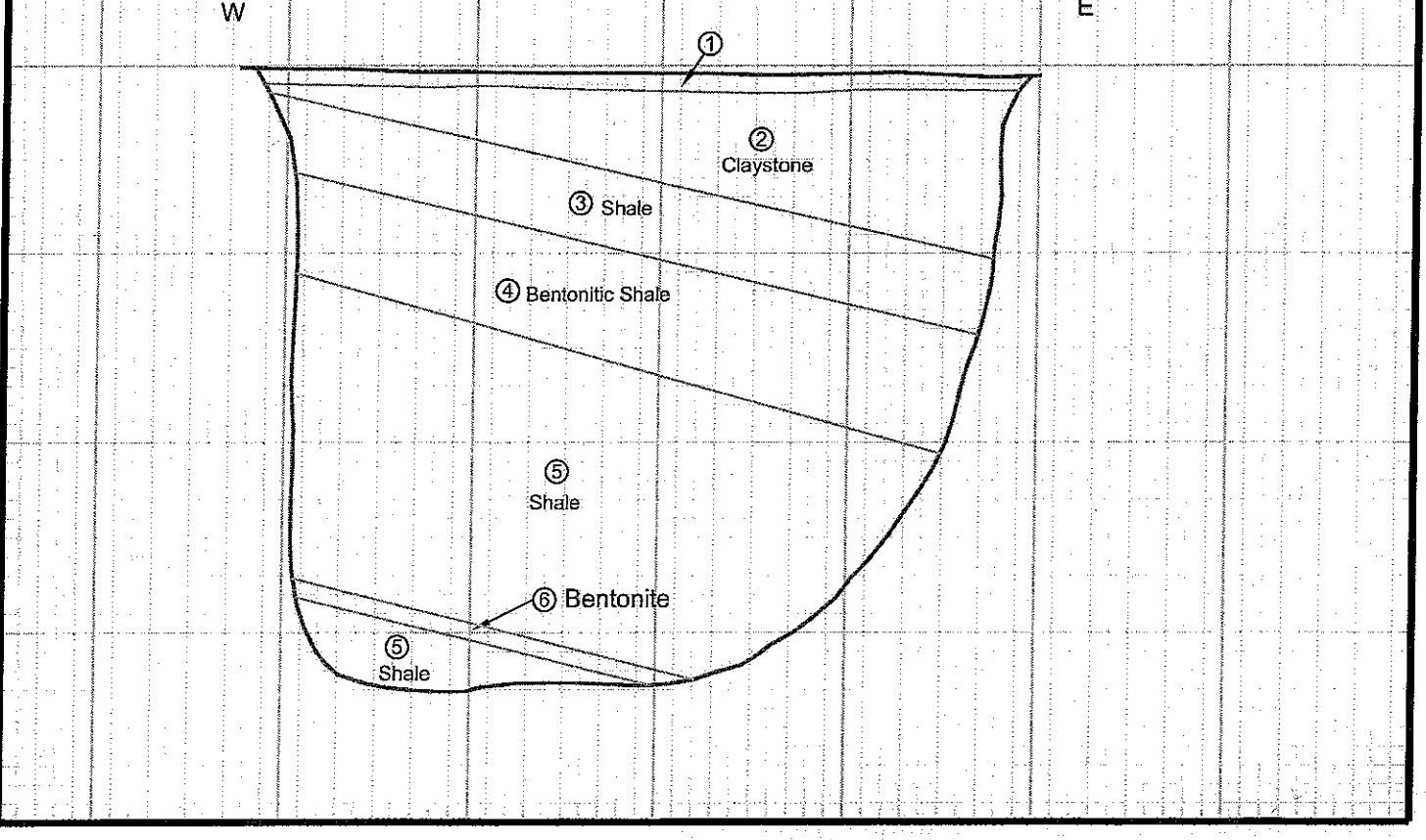
ORIENTATIONS

100 deg/20 deg NE

SAMPLES

No Samples Collected

Scale: 1 in.= 5 ft.



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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-10-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-11
TEST HOLE LOCATION: ~300' west of Lot #1	

ELEVATION G.S. (Ft.): 8122	TOTAL DEPTH (Ft.): 16	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.0' (Depth varies), sandy SILT with scattered gravel [TOPSOIL]					
2							1.0-8.0' Interbedded SHALE CLAYSTONE: Light to dark brown, weak, friable, thinly bedded to laminated, highly weathered [Intact beds - possibly some disTORTION] Orientation 122°/14°NE [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
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8		TP11-					8.0-9.0' BENTONITE: Pale yellow to white, slightly moist, stiff (1.5 tsf), plastic, stratified [INCIPIENT SHEAR] Orientation at base of bentonite, top of shale 160°/9° NE, shear 70°/55° S					
9												
10							9.0-16.0' SHALE: Very dark gray brown, dry to slightly moist, moderately strong, thinly bedded, blocky fracture, moderately weathered, oxidation along fracture planes, prominent 1/4" thick fractures 70° / 55° S [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
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PROJECT: Moonlight Basin Ranch Cowboy Heaven Phase 2, Big Sky, MT

TEST PIT: TP- 01-12

PIT LOCATION: ~550' W. of Lot #1, east edge of tree line

Approximate Pit Dimensions (feet): Length: 20 Width: 8 Depth: 16.5

Date: 7-10-01 Logged By: gsv

Approximate Surface Elevation: 8120' Log View Direction: south

Excavation Contractor: MBR Equipment: CAT 318B Excavator

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MATERIAL DESCRIPTIONS

① 0' - 0.3': Sandy SILT [Topsoil]

② 0.3' - 2' (varies): SILTSTONE; gray (weathers brown), dry to slightly moist, moderately hard, closely fractured, mod. to high weathering [Albino, Muddy, and Thermopolis Fm. Undif.]

③ 0.3' - 3' (varies): CLAYSTONE; bentonitic, yellow-brown, slightly moist, stiff, highly weathered [Albino, Muddy, and Thermopolis Fm. Undif.]

④ 0.3' - 6' (varies): SHALE; very dark brownish gray, dry to slightly moist, weak to moderately strong, very closely fractured, friable zones in upper portion, becomes harder near base of pit [Albino, Muddy, and Thermopolis Fm. Undif.]

⑤ 0.3' - 7' (varies): BENTONITE; pale yellow, slightly moist, stiff, highly plastic possibly incipient SHEAR ZONE [Albino, Muddy, and Thermopolis Fm. Undif.]

*possibly some bedding parallel movement in layers above Unit ⑤ (dip slope conditions - bedding inclined parallel to slope angle)

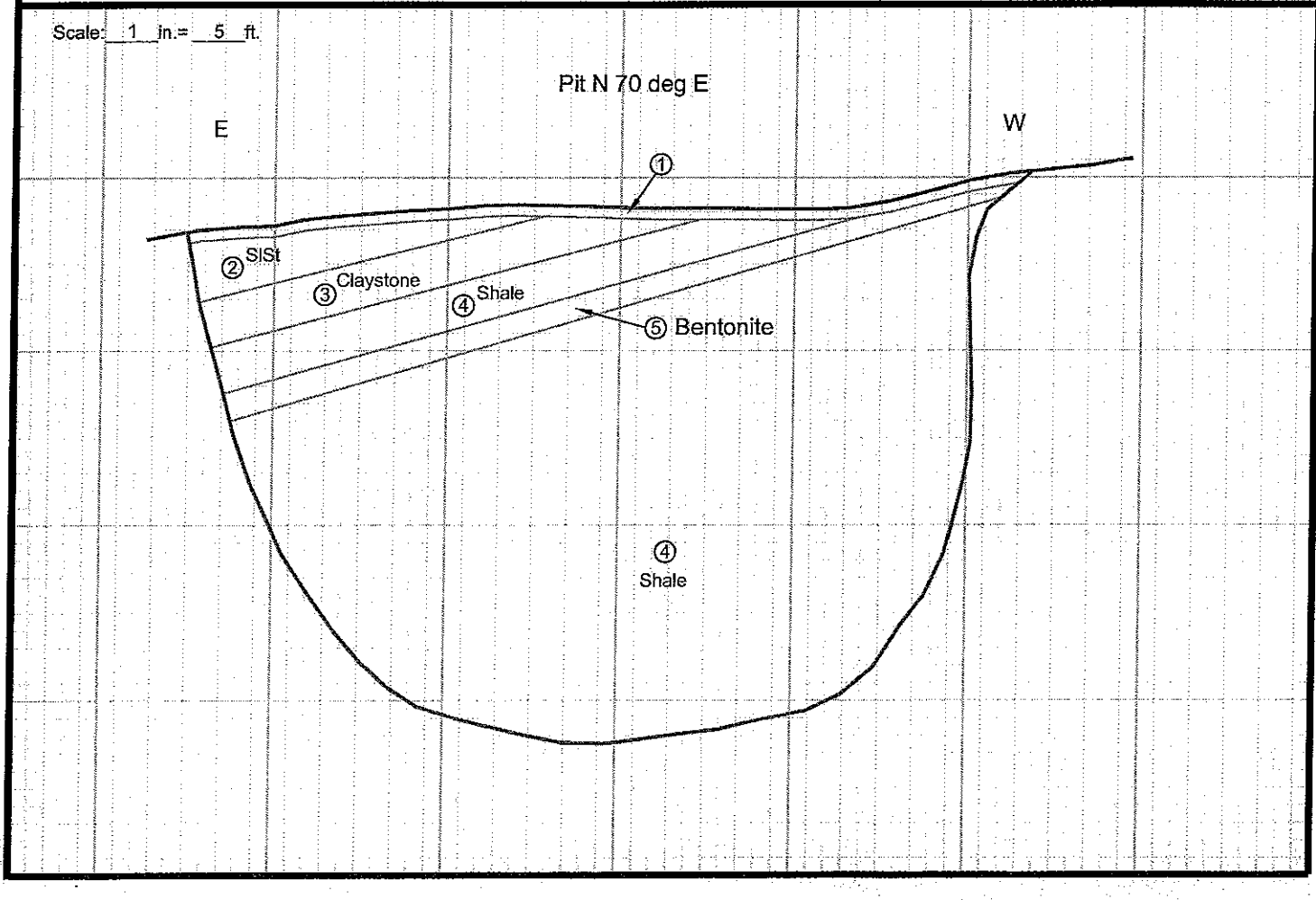
Note: Soil Classifications (USCS) based on field descriptions

ORIENTATIONS

109 deg/17 deg NE

SAMPLES

No Samples Collected



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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-10-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-13
TEST HOLE LOCATION: ~550 northwest of northwest corner Lot #1, east edge tree line	

ELEVATION G.S. (Ft.): 8076	TOTAL DEPTH (Ft.): 16	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–16							0.0-7.0' GRAVELLY CLAY: Light yellowish brown to gray, slightly moist to wet at minor seep zones, medium stiff, structureless (randomly oriented, discontinuous shale layers [LANDSLIDE DEBRIS]					
7–8							7.0-8.0' BENTONITE: Pale yellow to white, slightly moist, stiff to very stiff (1.5 tsf), highly plastic, scattered angular shale gravel and cobbles, orientation 129°/18° NE at base of bentonite/top of shale [SHEAR ZONE]					
8–16							8.0-16.0' SHALE: Very dark grayish brown, dry to slightly moist, moderately strong, thinly bedded to laminated, blocky fracture, minor small seeps [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
							Note: Hard, difficult digging near base of pit					

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-10-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-14
TEST HOLE LOCATION: About 250' northwest of northwest corner Lot #1	

ELEVATION G.S. (Ft.): 8164	TOTAL DEPTH (Ft.): 17	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–5							0.0-5.0' GRAVEL and COBBLES in a bentonitic clay matrix: Light yellowish brown to gray, slightly moist to wet at minor seep zones, medium stiff, structureless (randomly oriented, discontinuous shale layers [LANDSLIDE DEBRIS]					
5–10							5.0-10.0' SHALE: Very dark gray to black, dry, hard, blocky fracture, thickness varies from 1 - 3', some slickensides and shearing at lower contact, orientation 140°/20° NE at base of shale [LANDSLIDE DEBRIS]					
10–17							10.0-17.0' SHALE: Medium brown, dry to slightly moist, weak to moderately strong, thinly bedded to laminated, blocky fracture (appears to be in place bedrock) [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
17–19												

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-10-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-15
TEST HOLE LOCATION: ~100' north/northwest of the northwest corner of Lot #1	

ELEVATION G.S. (Ft.): 8044	TOTAL DEPTH (Ft.): 14	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–19							0.0-1.0' Sandy SILT with scattered gravel: Light to dark brown, slightly moist, very loose, roots and organic debris [TOPSOIL] 1.0-12.0' GRAVEL and COBBLES with a CLAY matrix: Color mixed, light to dark brown, moist, loose, discontinuous lenses and pockets of shale [LANDSLIDE DEBRIS] 12.0-13.5' BENTONITE: White to pale yellow, moist to wet, soft to medium stiff (0.25 to 0.75 tsf), minor seepage along bottom contact, appears to dip about 10-15° NE [SHEAR ZONE] 13.5-14.0' SHALE: Black, dry to slightly moist, moderately strong, difficult digging [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED] Note: Excavator refusal at 14', very hard. Pit walls unstable, did not enter pit below 9'					

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-10-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-16
TEST HOLE LOCATION: ~150' north of Lot #3	

ELEVATION G.S. (Ft.): 8032	TOTAL DEPTH (Ft.): 20	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–19							0.0-0.5' Sandy SILT: Very dark brown, slightly moist, very loose, roots and organics [TOPSOIL] 0.5-15.0' GRAVEL and COBBLES with a clayey sand matrix: Reddish brown, slightly moist to moist (becomes very moist at 8'), loose to medium dense, massive, angular shale gravel and small cobbles, about 60% angular to subangular andesite gravel and cobbles to 10", 20-30% fine to coarse grained sand, 10-20% plastic fines [GLACIAL DEPOSITS/LANDSLIDE] 15.0-20.0' GRAVEL and COBBLES with a sandy clay matrix: Brown to light brown, very moist to wet at ~19' (seepage into pit), loose, structureless, subangular to angular shale cobbles to 6", at 17' SHALE cobbles in clayey matrix Note: Pit collapsing at 17', walls collapsing - did not enter pit					

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-10-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-17
TEST HOLE LOCATION: About 200' northwest of pond, ~300' west of northwest corner Lot 13	

ELEVATION G.S. (Ft.): 7964	TOTAL DEPTH (Ft.): 17	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton

LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.0' Sandy SILT: [TOPSOIL]					
2							1.0-7.0' GRAVEL, COBBLES and small BOULDERS with sandy CLAY matrix: Color mixed, light to dark brown, gray to black, slightly moist to very moist, very loose to loose, angular shale and scattered andesite clasts [LANDSLIDE DEPOSITS]					
3												
4												
5												
6												
7							7.0-9.0' BENTONITE: Discontinuous layer					
8												
9							9.0-11.0' GRAVEL, COBBLES and small BOULDERS with sandy CLAY matrix: Color mixed, light to dark brown, gray to black, slightly moist to very moist, very loose to loose, angular shale and scattered andesite clasts [LANDSLIDE DEPOSITS]					
10												
11							11.0-11.5' BENTONITE:					
12							11.5-17.0' GRAVEL, COBBLES and small BOULDERS with sandy CLAY matrix: Color mixed, light to dark brown, gray to black, slightly moist to very moist (wet at 15'), very loose to loose, angular shale and scattered andesite clasts [LANDSLIDE DEPOSITS] Note: Pit walls collapsing					
13												
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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-10-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-18
TEST HOLE LOCATION: West of proposed road switchback, ~100' west of Lot #21	

ELEVATION G.S. (Ft.): 7916	TOTAL DEPTH (Ft.): 15	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.5' Silty CLAY: Dark brown, slightly moist to moist, soft, massive, organics [TOPSOIL]					
2							1.5-15.0' Mixed silty CLAY and SHALE: Very dark grayish brown, moist to wet (seepage at 8', pit filling with water at 12'), medium stiff clay, weak, friable shale, random orientation, becomes harder and more shale at 14' - difficult to see below water [LANDSLIDE DEPOSITS]					
3												
4							Note: Pit walls collapsing - did not enter pit below 8'					
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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-19
TEST HOLE LOCATION: South of Lot #2, south side of road	

ELEVATION G.S. (Ft.): 8124	TOTAL DEPTH (Ft.): 15	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.5' Sandy SILT: Medium to dark brown, dry to slightly moist, loose, massive, roots and organic debris [TOPSOIL]					
2							1.5-15.0' Sandy GRAVEL and COBBLES: Some clayey layers, light brown to reddish brown, dry to slightly moist (water seeping into pit at 14'), becomes moist at 10', medium dense, crude stratification in 1'-3' layers (parallel to ground slope), about 60% angular to subangular shale, sandstone and siltstone gravel and cobbles to 10", 25-30% fine to coarse grained sand, 10-15% fines [COLLUVIUM]					
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15							Note: Harder digging at 15', increase in shale cobble - probably top of shale bedrock					
16												
17												
18												
19												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-20
TEST HOLE LOCATION: Southeast corner of Lot #4, north side of road	

ELEVATION G.S. (Ft.): 8108	TOTAL DEPTH (Ft.): 15	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–15							0.0-15.0' GRAVEL and COBBLES with sandy clay to clayey sand matrix: Reddish brown, slightly moist to very moist, medium dense, massive, about 60% angular to subangular andesite and shale clasts to 8", 20% fine to coarse grained sand, 20% plastic fines [COLLUVIUM] Note: Increase in cobbles in lower 5' of pit, no seepage. Top ~1.5' topsoil stripped by dozer					

TEST_HOLE_LOG2 MLBROHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-21
TEST HOLE LOCATION: South side of Lot #7, north side of road	

ELEVATION G.S. (Ft.): 8104	TOTAL DEPTH (Ft.): 18	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–18							0.0-18.0' GRAVEL and COBBLES with a clayey sand matrix: Reddish brown, moist, loose, massive, about 60-70% subangular to angular gravel and cobbles to 10" (andesite and shale), 25-30% fine to coarse grained sand, 5-10% plastic fines, no seepage [GLACIAL DEPOISTS/COLLUVIUM] Note: Top ~1.5' topsoil stripped by dozer					
19												

TEST_HOLE_LOG2_MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-22
TEST HOLE LOCATION: End of cul-de-sac, lower road, northeast of Lot 23	

ELEVATION G.S. (Ft.): 7856	TOTAL DEPTH (Ft.): 18	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION / COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.5' Sandy SILT: [TOPSOIL]					
2							1.5-9.0' GRAVEL and COBBLES with a clayey sand to sandy clay matrix: Reddish brown, loose to medium dense, mostly massive with occasional thin lenses of sandy gravel, about 60% angular to subrounded gravel and cobbles, andesite and shale clasts, 40% matrix, seepage at 7'-8' above clay [LANDSLIDE DEPOSITS]					
3												
4												
5												
6												
7												
8												
9							9.0-15.0' Gravelly CLAY: Gray, slightly moist to moist, stiff to very stiff, massive, about 50-60% plastic clay, 40-50% coarse grained sand, subrounded gravel and scattered cobbles [LANDSLIDE DEPOSITS]					
10												
11		TP22-1										
12												
13												
14												
15							15.0-18.0' GRAVEL and COBBLES with coarse sandy matrix: Light brown, wet (seepage at 16'), very loose, massive, andesite and shale clasts, 80-90% subangular to angular gravel and cobbles to 10", water filling pit, pit collapsing below 15' [LANDSLIDE DEPOSITS]					
16												
17												
18												
19												

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch			DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2			HOLE NO.: TP-01-23
TEST HOLE LOCATION: North side of Lot #24			
ELEVATION G.S. (Ft.): 7845	TOTAL DEPTH (Ft.): 17	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.0' Sandy SILT: [TOPSOIL]					
2							1.0-17.0' GRAVEL and COBBLES with clayey sand matrix: Light brown, moist, loose, massive, about 60% subangular to angular shale and sandstone gravel and cobbles to 10", 25-30% fine to coarse grained sand, 10-15% plastic clay, increase in large cobbles and small boulders with depth, no seepage, pit walls unstable [COLLUVIUM/LANDSLIDE DEPOSITS]					
3												
4												
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TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-24
TEST HOLE LOCATION: South side of Lot #34	

ELEVATION G.S. (Ft.): 7872	TOTAL DEPTH (Ft.): 17	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
0							0.0-1.0' Sandy SILT: [TOPSOIL]					
1							1.0-1.8' Gravelly silty SAND: Light brown, slightly moist, loose, massive [COLLUVIUM]					
2							1.8-17.0' SHALE: Dark brown to dark gray, dry to slightly moist, thinly bedded to laminated, weak, friable, highly weathered in upper 1.5' (residual soil), moderately weathered below 3', becomes hard at 17' [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
3												
4							Bedding orientation $110^0/14^0$ NE					
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18												
19												

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-25
TEST HOLE LOCATION: North side of Lot #25	

ELEVATION G.S. (Ft.): 7860	TOTAL DEPTH (Ft.): 20	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1							0.0-1.0' Sandy SILT: Dark brown, slightly moist, loose, organics [TOPSOIL]					
2							1.0-3.0' Gravelly silty SAND: Light brown, slightly moist, loose, massive [COLLUVIUM]					
3												
4							3.0-6.0' Sandy GRAVEL: Very dark grayish brown, dry to slightly moist, medium dense, massive, entirely shale clasts 1" to 3", angular, random orientation [COLLUVIUM]					
5												
6							6.0-20.0' SHALE: Dark brown to dark gray, dry to slightly moist, thinly bedded to laminated, weak, friable, highly weathered in upper 1.5' (residual soil), moderately weathered below 3', very closely fractured, some interbedded siltstone [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]					
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 7-11-01
PROJECT LOCATION: Cowboy Heaven, Phase 2	HOLE NO.: TP-01-26
TEST HOLE LOCATION: South side of Lot #36	

ELEVATION G.S. (Ft.): 7904	TOTAL DEPTH (Ft.): 17	GROUNDWATER LEVEL (Ft.): NA	MEASURED FROM:
DRILL TYPE: CAT 318B Excavator	HAMMER:	DRILL CO: MBR	DRILLER: Clayton	LOGGED BY: gsv

DEPTH (Ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION COMMENTS:	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–17							0.0-1.0' Sandy SILT: [TOPSOIL] 1.0-3.7' Clayey GRAVEL with COBBLES: Light to medium brown, moist, loose, massive, predominantly siltstone and sandstone gravel and cobbles in a sandy clay matrix, some bentonitic clay zones at lower contact [COLLUVIUM] 3.7-17.0' SHALE: Very dark grayish brown, slightly moist to moist, weak, friable, thinly bedded to laminated, very closely fractured, orientation 110°/20° NE [ALBINO, MUDDY and THERMOPOLIS FORMATION UNDIFFERENTIATED]]					

TEST_HOLE_LOG2 MLBRCHP2.GPJ WOMACK.GDT 8/9/01

PROJECT: Cowboy Heaven Phase 3, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-4

PIT LOCATION: south corner between Lots 15 and 16, about 15' north of road

Approximate Pit Dimensions (feet): Length: 15 Width: 8 Depth: 13

Date: 7-10-02 Logged By: gsv

Approximate Surface Elevation: 7956' Log View Direction: south

Excavation Contractor: MBR Equipment: CAT Excavator

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MATERIAL DESCRIPTIONS

① 0' - 6': Gravelly SAND; reddish to yellowish brown, slightly moist, loose to medium dense, massive, about 30-40% subangular gravel to 3" in diameter, 40-50% fine- to coarse-grained sand, 10-20% low plastic fines [Colluvium]

② 6' - 11': Sandy GRAVEL; as above except about 50-60% subangular gravel, scattered cobbles to 6" in diameter [Colluvium]

③ 11' - 13': Sandy CLAY with Gravel; very light gray to pale yellow, moist, stiff, some oxidation banding, about 30% fine-grained sand, 15% subangular siltstone gravel to 3" in diameter, 55% plastic fines (appears bentonitic) [reworked bentonite layer/Colluvium]

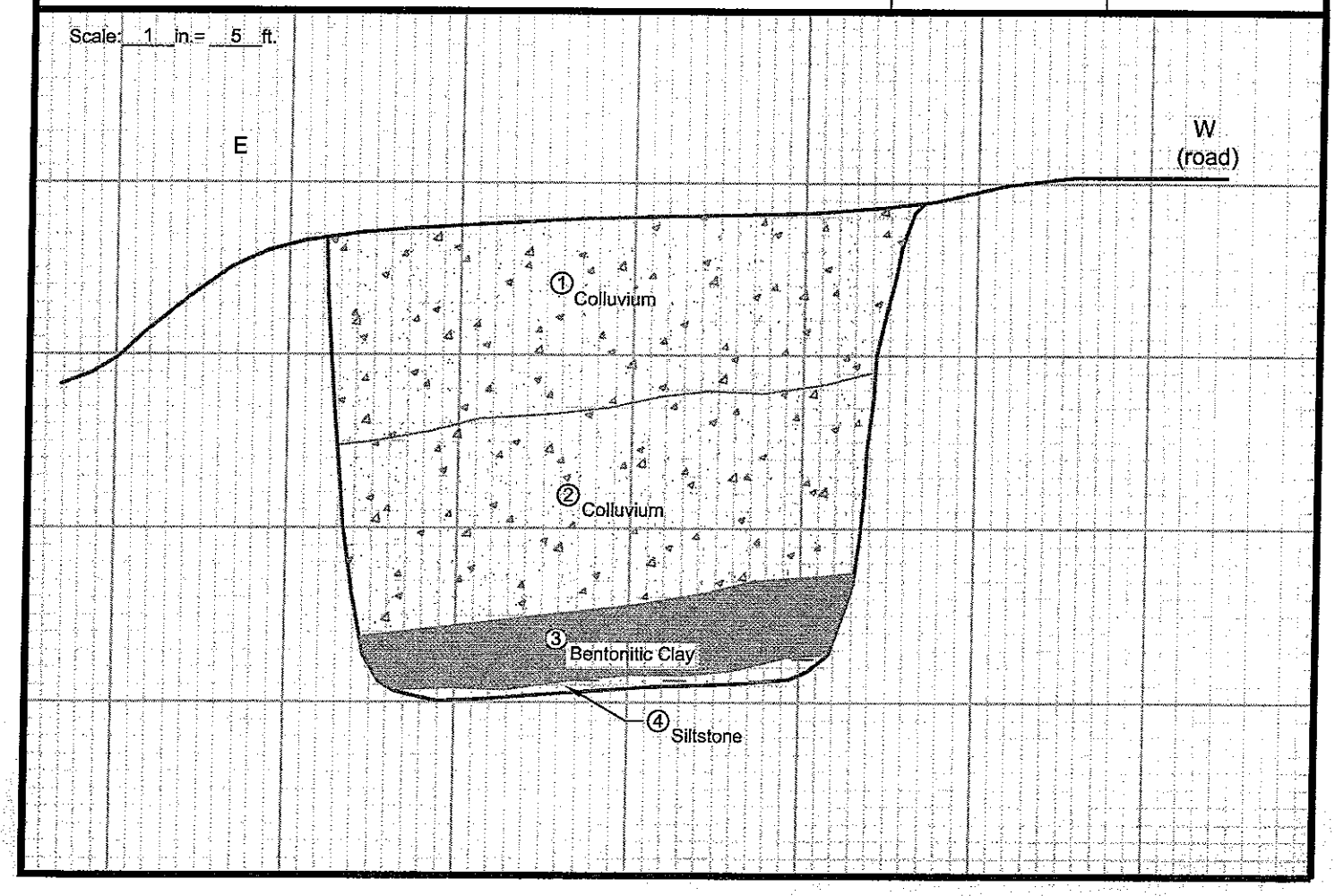
④ 13' - 13.5': SILTSTONE; light grayish brown, hard [Albino, Muddy, and Thermopolis Fm. undiff.]

Note: Soil Classifications (USCS) based on field descriptions

ORIENTATIONS

SAMPLES

No Samples Collected



PROJECT: Cowboy Heaven Phase 3, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-5

PIT LOCATION: about 100' north of SW corner Lot 20

Approximate Pit Dimensions (feet): Length: 17 Width: 12 Depth: 18

Date: 7-10-02 Logged By: gsv

Approximate Surface Elevation: ~7940' Log View Direction: south

Excavation Contractor: MBR Equipment: CAT Excavator

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MATERIAL DESCRIPTIONS

① 0' - 11.5' west end, 0' - 14.5' east end: GRAVEL and COBBLES in Sandy CLAY matrix; about 40-60% angular, platy shale and siltstone clasts, about 40-60% sandy plastic clay matrix, dark brown, stiff, crude stratification parallel to slope [Colluvium]

② 0.5' thick: Sandy CLAY with scattered angular gravel; light yellowish brown to gray, moist to very moist, stiff, oxidation banding, appears to be bentonitic clay, seepage at shale contact [reworked bentonitic layer/Colluvium]

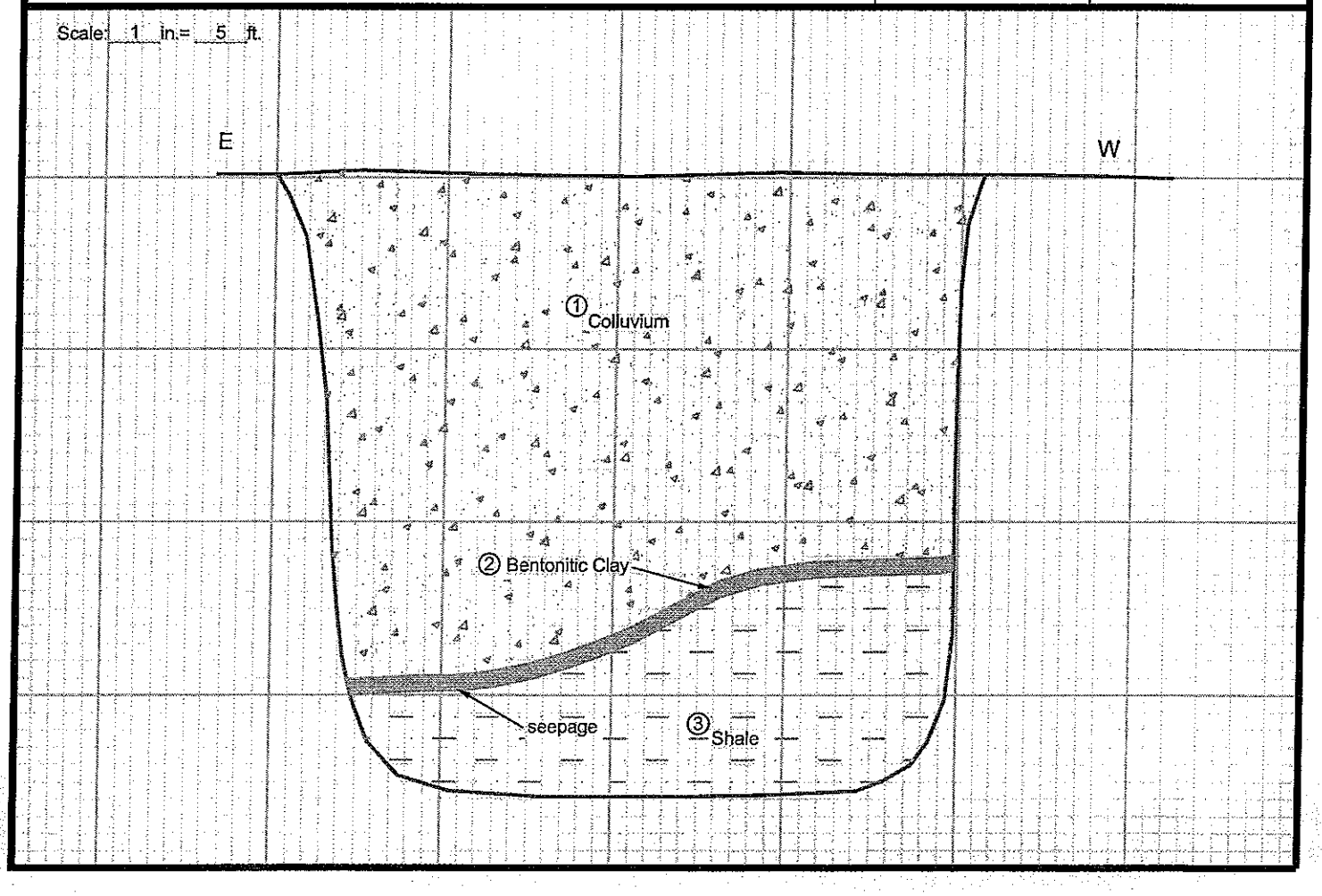
③ 12' - 18' west end, 15' - 18' east end: SHALE; dark grayish brown, thinly bedded to laminated, weak, friable [Albino, Muddy, and Thermopolis Fm. undiff.]

ORIENTATIONS

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-6

PIT LOCATION: Lot 12, centerline ski run right-of-way

Approximate Pit Dimensions (feet): Length: 12 Width: 10 Depth: 16

Date: 7-11-02 Logged By: gsv

Approximate Surface Elevation: ~8020' Log View Direction: south

Excavation Contractor: MBR Equipment: CAT Excavator

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MATERIAL DESCRIPTIONS

① 0' - 12': GRAVEL, COBBLES, and BOULDERS with Sandy CLAY matrix; grayish brown to brown, slightly moist to wet at 11' (seepage), loose to medium dense, crudely stratified parallel to slope, about 60% subangular to angular clasts of siltstone, sandstone, and andesite, about 40% sandy plastic clay matrix (pit walls collapsing) [Colluvium/possibly older landslide deposits]

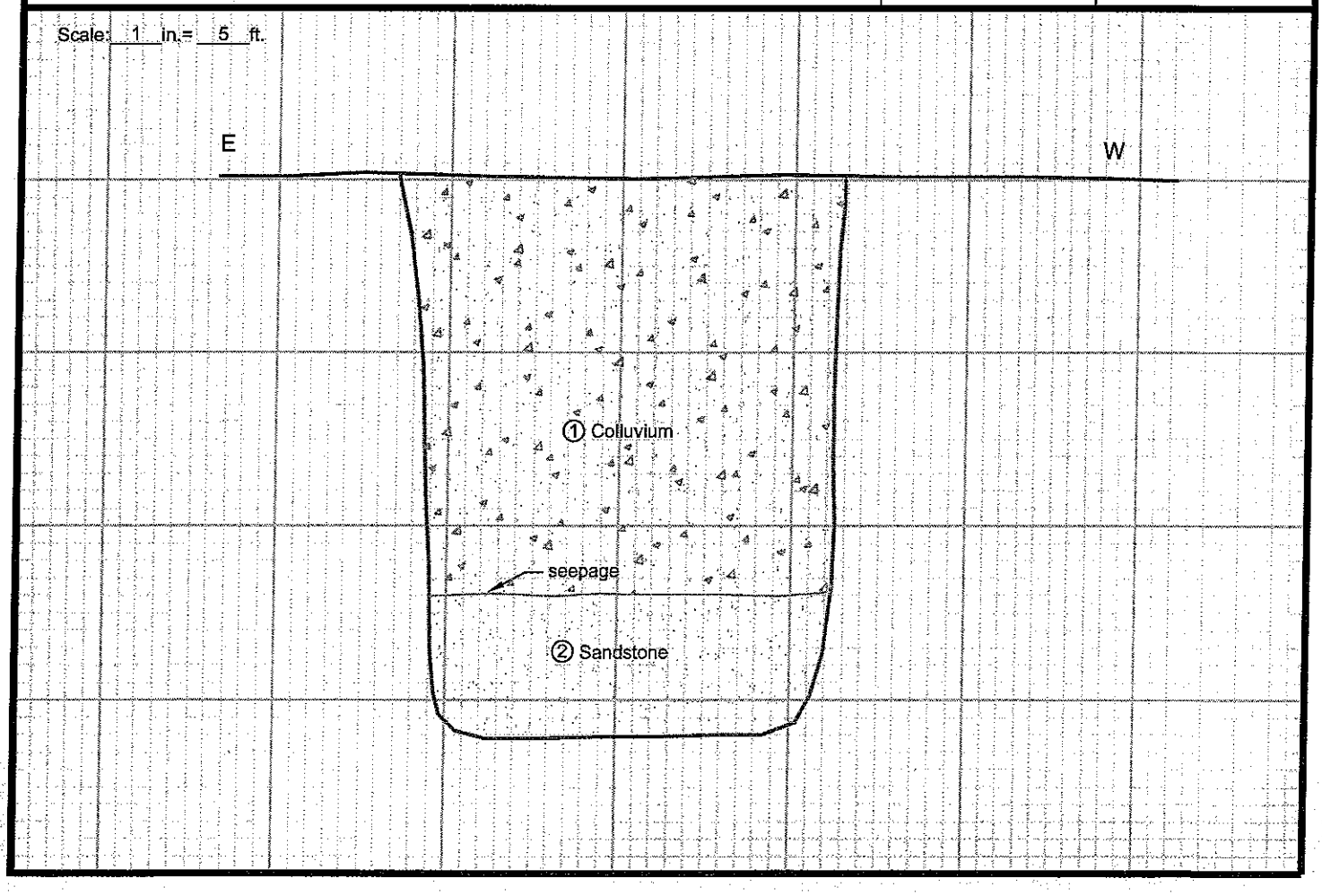
② 12' - 16': SANDSTONE; light brownish gray, thin to medium bedding, hard, fractured [Albino, Muddy, and Thermopolis Formation undifferentiated]

ORIENTATIONS

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 4, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-7

PIT LOCATION: east side Pony Express Lift parking lot

Approximate Pit Dimensions (feet): Length: 15 Width: 8 Depth: 16

Date: 7-11-02 Logged By: gsv

Approximate Surface Elevation: ~7760' Log View Direction: south

Excavation Contractor: MBR Equipment: CAT Excavator

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MATERIAL DESCRIPTIONS

① 0' - 5': GRAVEL and COBBLES with clayey sand matrix; mixed dark gray and brown, slightly moist, medium dense, stratified in 1-foot thick lifts, scattered roots, strong odor from decaying organics [Fill]

② 5' - 6': Sandy SILT; dark reddish brown, slightly moist, soft to medium stiff, massive some roots [Buried Topsoil Layer]

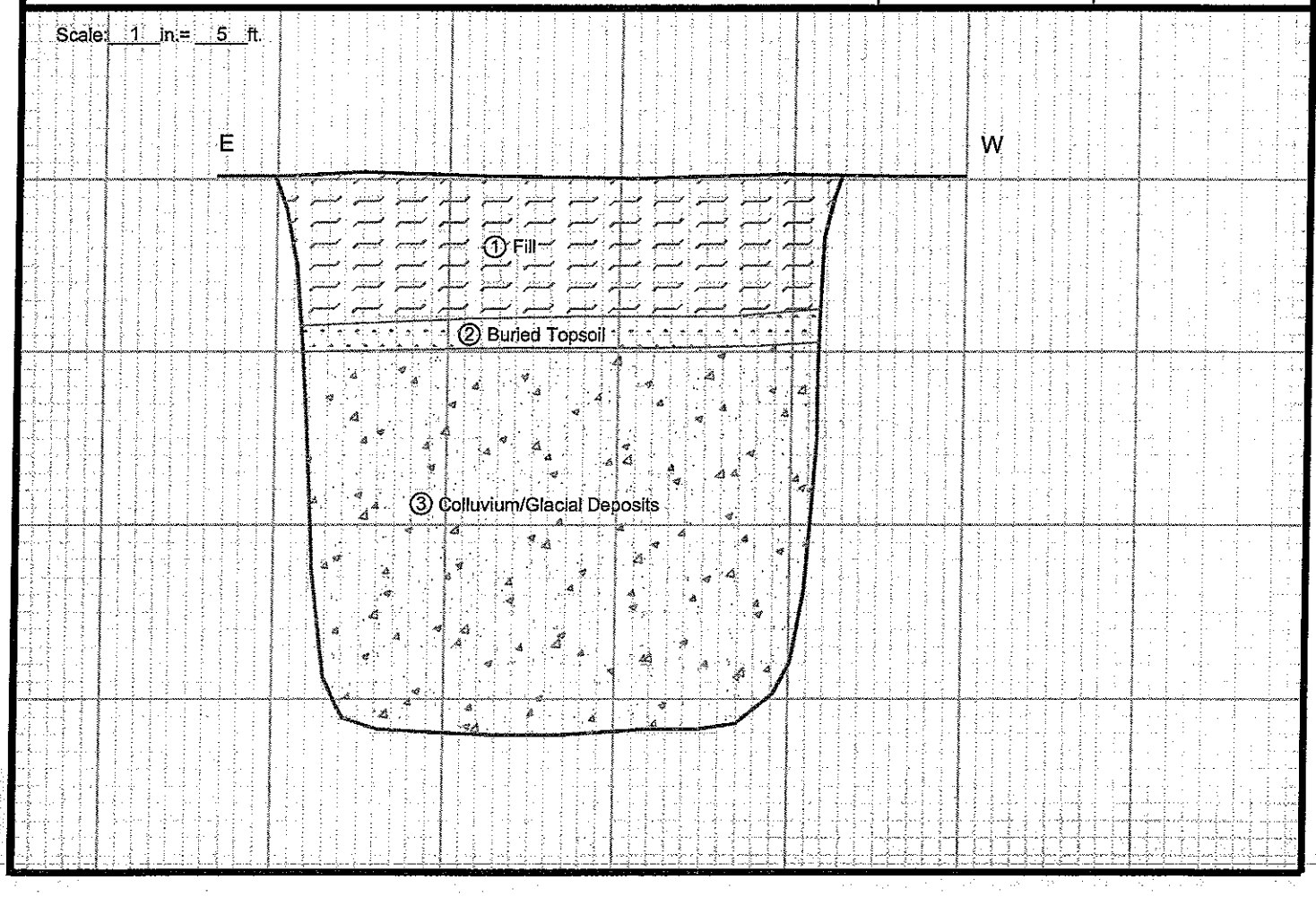
③ 6' - 16': GRAVEL, COBBLES, and BOULDERS with clayey sand matrix; medium brown, slightly moist to moist, medium dense, massive, about 70% coarse, angular to subangular clasts up to 1.5' in diameter including andesite, sandstone, and siltstone, about 30% clayey sand matrix [Colluvium/Glacial Deposits]

ORIENTATIONS

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-8

PIT LOCATION: Central portion Lot 42, west edge of ski run

Approximate Pit Dimensions (feet): Length: 15 Width: 4 Depth: 10.5

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8116' Log View Direction: northeast

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 1.5': Gravelly CLAY; light brown, moist, soft, massive, about 40% angular weathered claystone/shale gravel to 3 inches in diameter, roots and sod near surface [Colluvium]

② 1.5' - 10.5': CLAYSTONE/SHALE; light gray, weathers to light brown, slightly moist, very weak to weak, thinly bedded, very closely fractured, easily breaks into 3/8" to 1" pieces, moderately weathered, interbedded with 4" to 6" layers of hard siltstone [Albino, Muddy, and Thermopolis Fm. undifferentiated]

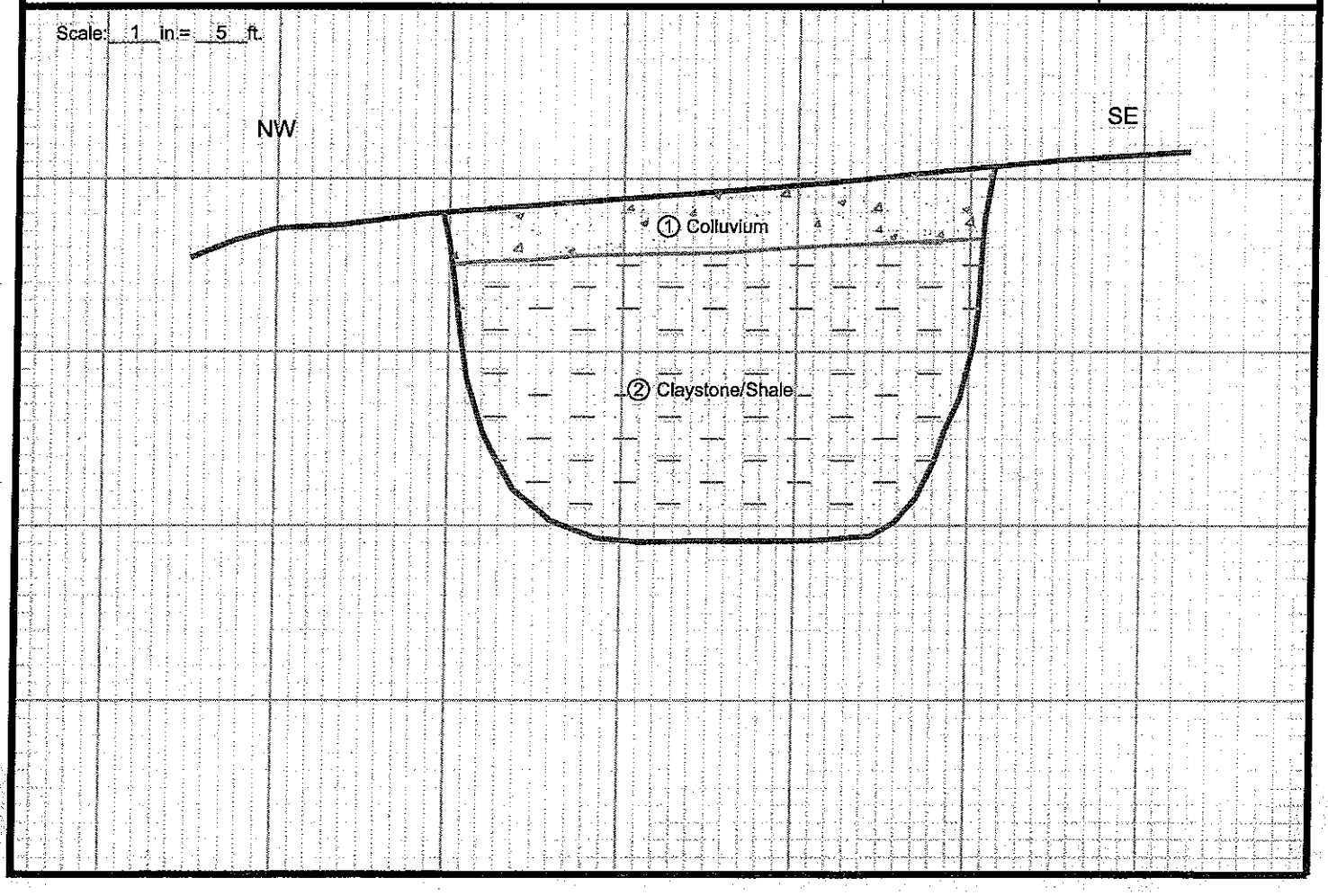
ORIENTATIONS

siltstone
280/22 NE

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-9

PIT LOCATION: Near northeast corner of Lot 42, east edge of ski run

Approximate Pit Dimensions (feet): Length: 15 Width: 4 Depth: 17

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8080' Log View Direction: west

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 1.8': Sandy GRAVEL with Cobbles; medium to dark brown, moist, loose, massive, roots [Colluvium]

② 1.8' - 6.0': SANDSTONE; very fine- to fine-grained, light gray weathering to light brown, moderately strong, medium to closely fractured, breakes into 3" to 1' blocks, sand filling fractures, moderately weathered [Albino, Muddy, and Thermopolis Fm. undifferentiated]

③ 6.0' - 15.0': SHALE; dark grayish brown, moist, weak, thinly bedded to laminated, fissile, closely to very closely fractured, moderately weathered [Albino, Muddy, and Thermopolis Fm. undifferentiated]

@ 7.8': 2" to 3" thick layer of yellow clay; medium stiff to stiff with some soft pockets

@ 14.5' - 15': Sandy CLAY (appears bentonitic); light yellow-brown, moist, stiff, some gravel

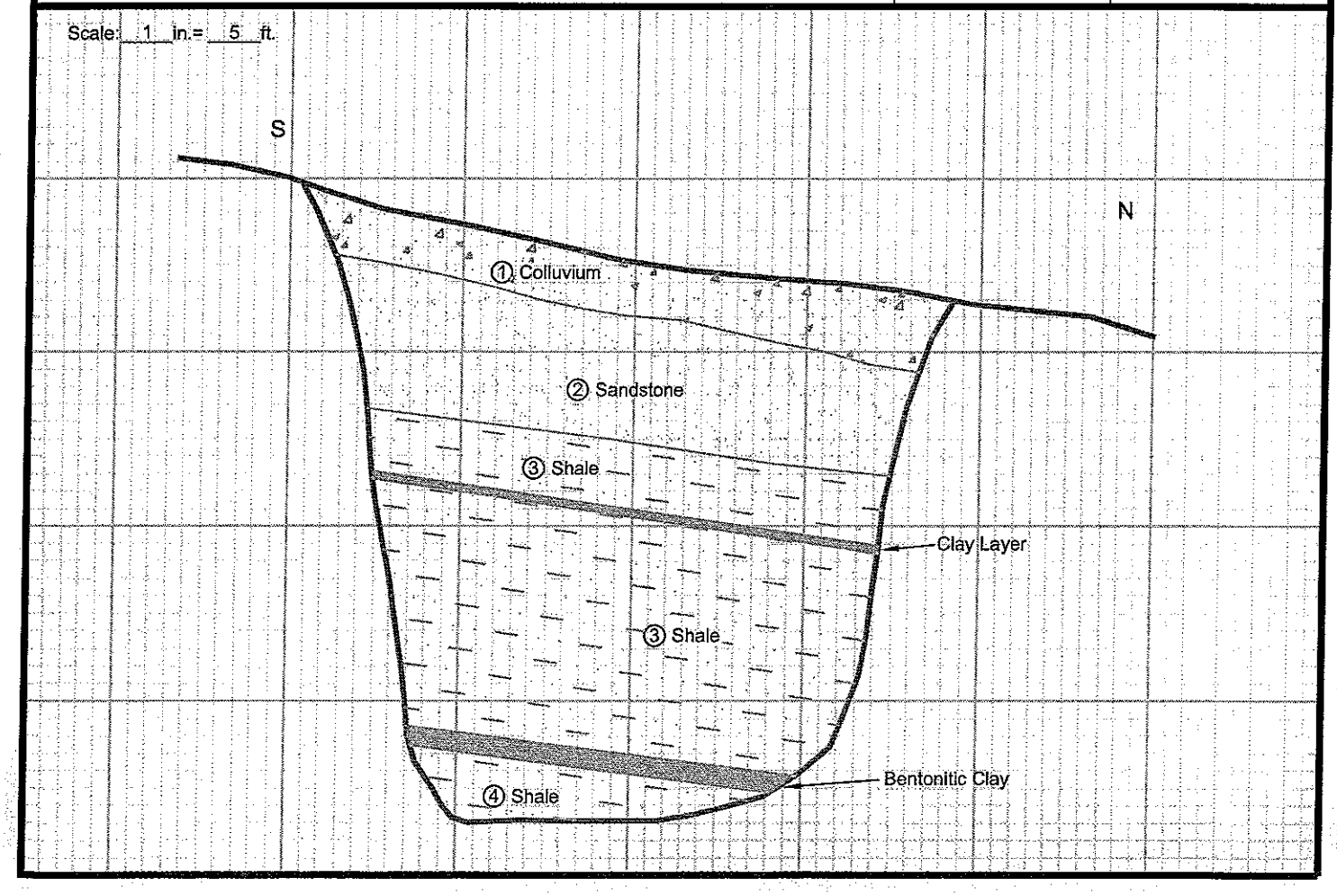
④ 15' - 17': SHALE; very dark brownish gray to black, thinly bedded to laminated, moderately strong, fissile, closely fractured, slightly to moderately weathered [Albino, Muddy, and Thermopolis Fm. undifferentiated]

Note: Soil Classifications (USCS) based on field descriptions

ORIENTATIONS

SAMPLES

No Samples Collected



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-10

PIT LOCATION: ~200' north of Lot 42, west edge of ski run

Approximate Pit Dimensions (feet): Length: 16 Width: 5 Depth: 12

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8072' Log View Direction: northeast

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 2': Gravelly CLAY; brownish gray, mosit, medium stiff, massive, angular shale and sandstone gravel to 2" in diameter [Colluvium]

② 2' - 12': SHALE; silty, dark brown to black, moist, very weak to weak, fissile, thinly bedded to laminated, very closely fractured [Albino, Muddy, and Thermopolis Fm undifferentiated]

@ 4': yellowish brown gravelly CLAY layer, moist, medium stiff, plastic

@ 8' to 10': grades to sandy SHALE

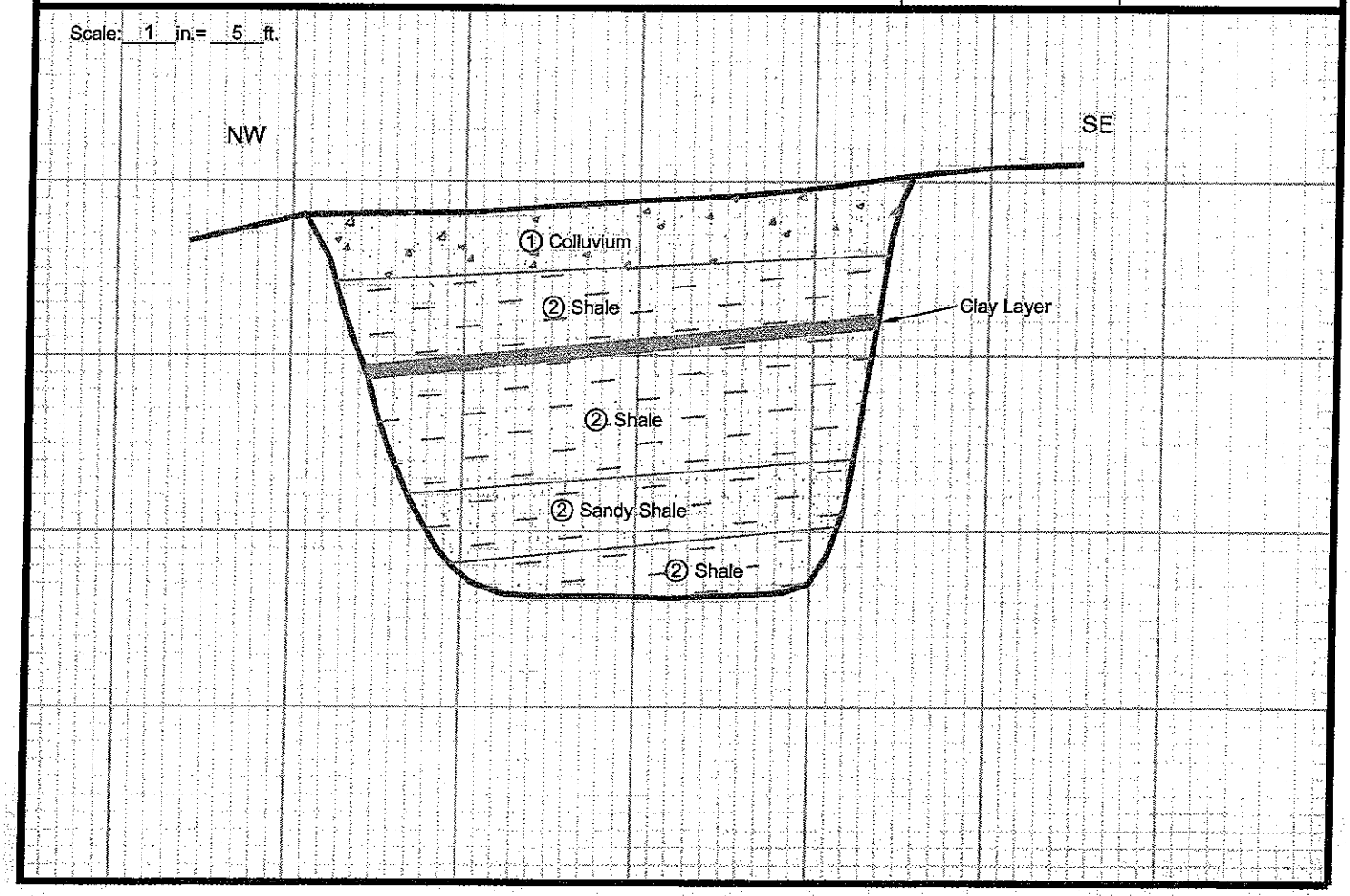
ORIENTATIONS

clay layer
105/20 N

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-11

PIT LOCATION: Approximately 400' north of Lot 42, east edge of ski run

Approximate Pit Dimensions (feet): Length: 17 Width: 5 Depth: 12

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8032' Log View Direction: west

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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(406) 656-5398 (fax) 656-8912

MATERIAL DESCRIPTIONS

① 0' - 2.4': Sandy CLAY; grayish brown, moist, medium stiff, massive, angular coarse-grained sand and gravel to 1" in diameter (shale gravel), roots [Colluvium]

② 2.4' - 8.6': SHALE; light to dark brownish gray, slightly moist, very weak, thinly bedded, highly to moderately weathered, very closely to closely fractured, some internal shearing (arcuate, discontinuous 1/4" thick clay seam) [Albino, muddy, and Thermopolis Fm. undifferentiated]

@ 5': 3" thick layer of yellow bentonitic CLAY; slightly moist, stiff, inclined at ~20 degrees N

@ 8': 7" thick layer of light yellowish gray bentonitic CLAY, moist, medium stiff to stiff

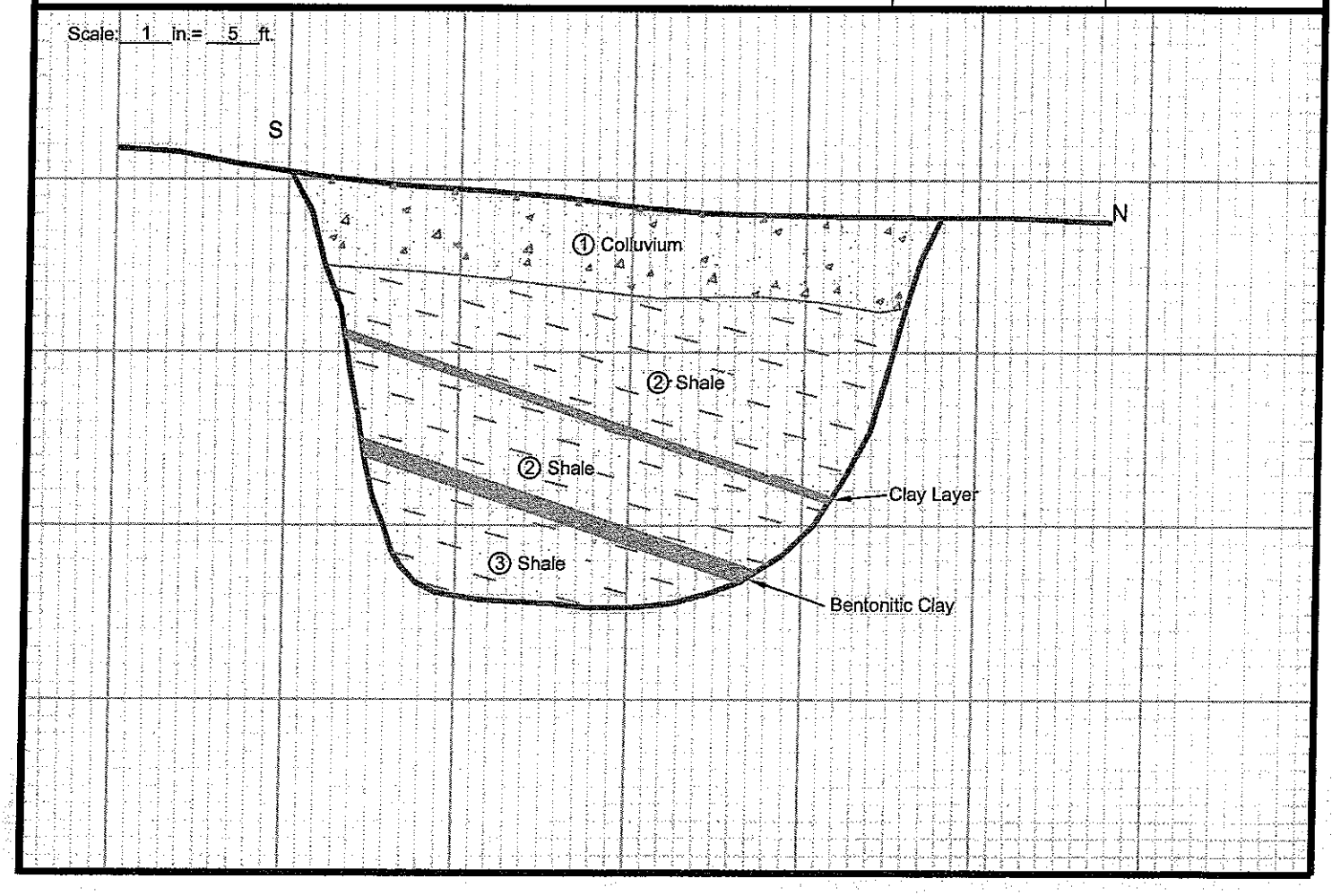
③ 15' - 17': SHALE; very dark brownish gray to black, thinly bedded to laminated, moderately strong, fissile, closely fractured, slightly to moderately weathered [Albino, Muddy, and Thermopolis Fm. undifferentiated]

ORIENTATIONS

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-12

PIT LOCATION: Northeast portion of Lot 37, west edge of ski run

Approximate Pit Dimensions (feet): Length: 17 Width: 5 Depth: 15

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8144' Log View Direction: east

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Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

MATERIAL DESCRIPTIONS

① 0' - 3': Gravelly to Sandy CLAY; light grayish brown, moist, stiff, plastic, massive, about 20-30% angular sandstone and shale gravel to 3" in diameter, about 10-15% fine- to coarse-grained sand [Colluvium]

② 3' - 7': SHALE; brownish gray weathering to light brown, slightly moist to moist, very weak, very thinly bedded, very closely fractured, moderately weathered, some internal shearing (arcuate, discontinuous fractures and contorted beds) [Albino, Muddy, and Thermopolis Fm. undifferentiated]

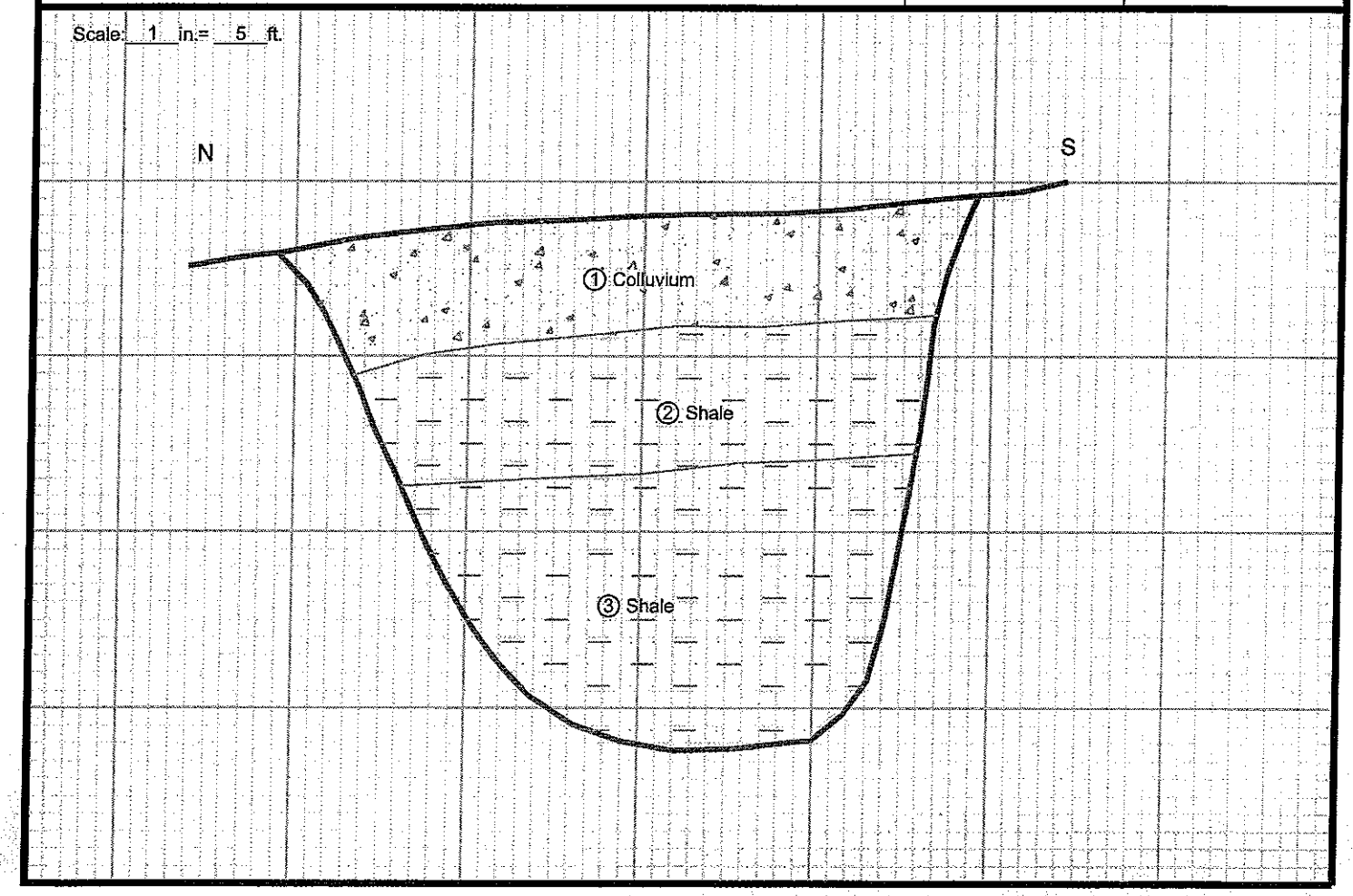
③ 7' - 15': SHALE; very dark brownish gray to black, slightly moist, weak, very thin to medium bedding with 6" to 1.5' beds, closely to moderately fractured, moderately weatered [Albino, Muddy, and Thermopolis Fm. undifferentiated]

ORIENTATIONS

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-13

PIT LOCATION: East portion of Lot 37, west edge of ski run

Approximate Pit Dimensions (feet): Length: 15 Width: 5 Depth: 15

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8172' Log View Direction: east

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 3': Gravelly to Sandy CLAY; light grayish brown, moist, stiff, plastic, massive, angular shale and sandstone gravel to 2" in diameter, roots [Colluvium]

② 3' - 12': SHALE; silty, light brownish gray, slightly moist, very weak to weak, very thinly bedded, highly to moderately weathered, very closely to closely fractured, some arcuate, discontinuous fracture planes, reddish brown mottling [Albino, Muddy, and Thermopolis Fm. undifferentiated]

@ 12': 3" thick layer of light yellowish gray bentonitic CLAY, moist, stiff to stiff

③ 12.3' - 15': SHALE; very dark brownish gray to black, very thinly bedded to laminated, moderately strong, fissile, closely fractured, slightly to moderately weathered [Albino, Muddy, and Thermopolis Fm. undifferentiated]

ORIENTATIONS

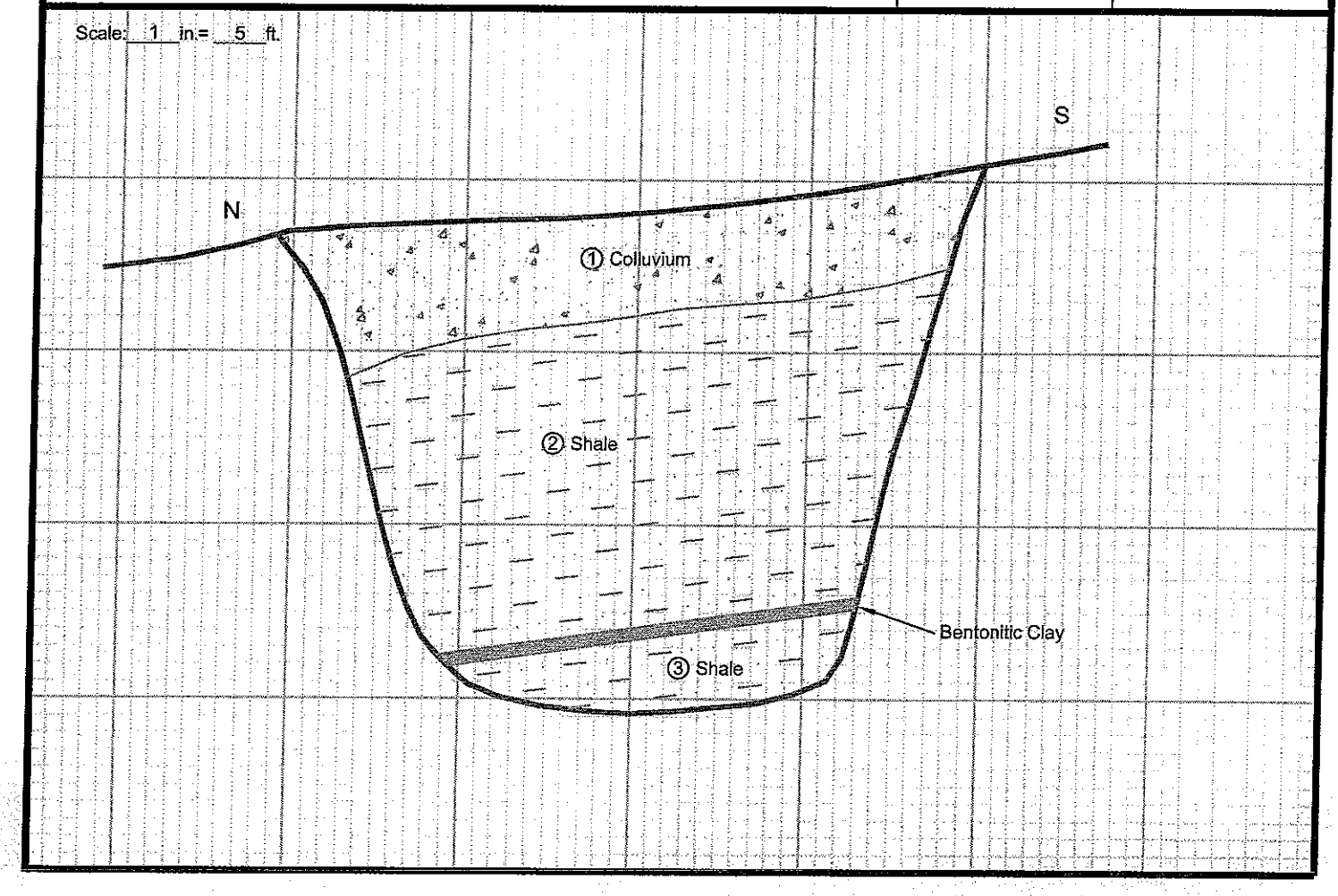
Shale bed 280/33 N

*possibly fracture plane, slightly steeper than bedding (?)

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-14

PIT LOCATION: East portion of Lot 41, west edge of road

Approximate Pit Dimensions (feet): Length: 18 Width: 5 Depth: 15

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8116' Log View Direction: south

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 3': (east end of pit) Fill under road prism, silty soil and organic debris from logging

② 0' - 6.5': (west end of pit) Gravelly CLAY with Cobbles; brown, moist to very moist, medium stiff to stiff, massive, plastic, angular shale and sandstone gravel to 3" in diameter, angular sandstone cobbles to 1.5' in diameter [Colluvium]

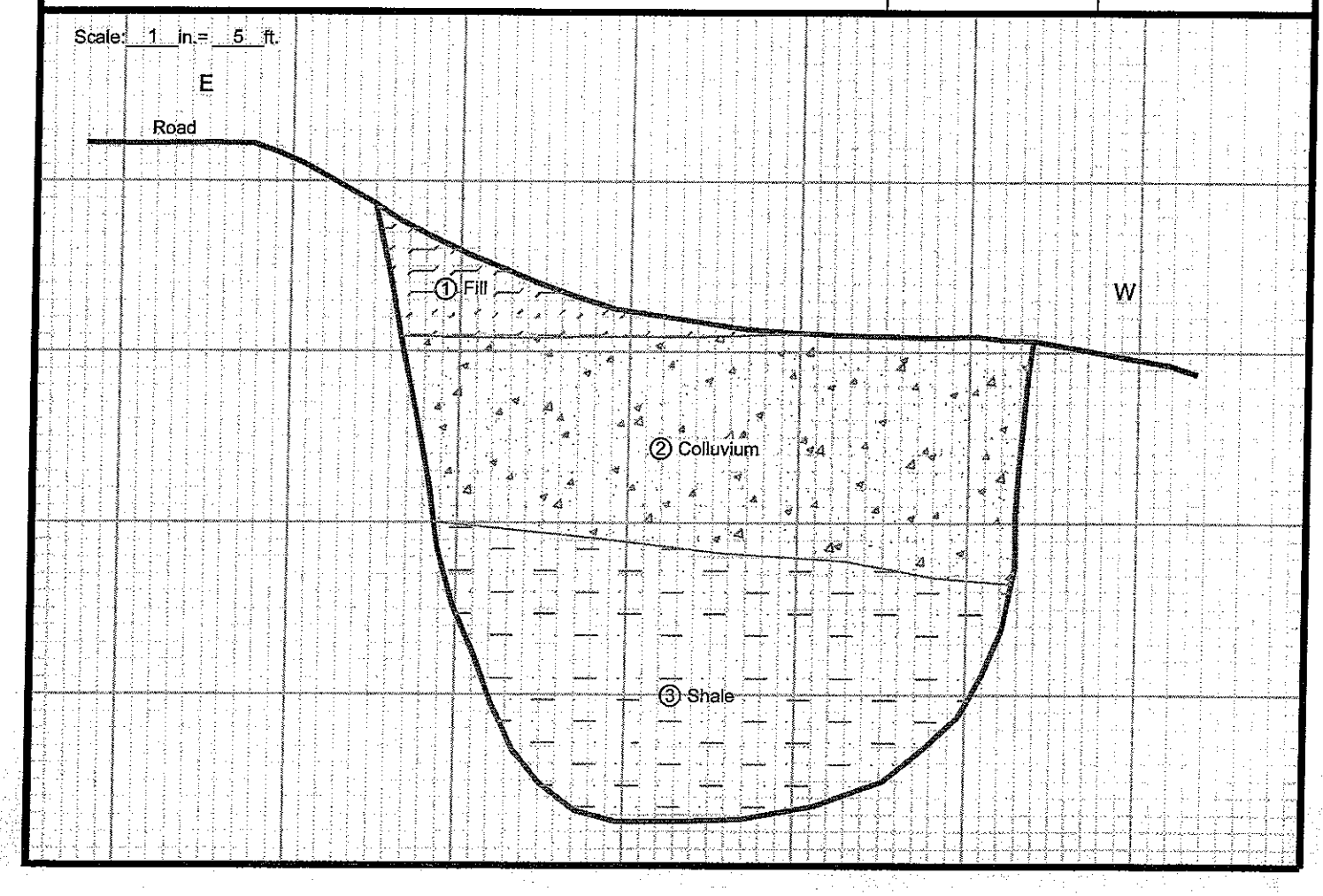
③ 6.5' - 15': SHALE; dark brown to brownish gray, moist to wet at contact (seepage at 6.5'), very weak to weak, very thinly bedded, very closely fractured, highly to moderately weathered [Albino, Muddy, and Thermopolis Fm. undifferentiated]

Note: Soil Classifications (USCS) based on field descriptions

ORIENTATIONS

SAMPLES

No Samples Collected



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-15

PIT LOCATION: Southwest portion of Lot 41, northeast edge of road

Approximate Pit Dimensions (feet): Length: 18 Width: 5 Depth: 18

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8116' Log View Direction: north

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 2.5': GRAVEL and COBBLES with Silty Sand matrix; dark reddish brown, moist, loose, massive, subangular sandstone and andesite gravel to 3" in diameter, cobbles to 5" in diameter [Colluvium]

② 2.5' - 4.7': Silty SAND; strong reddish brown, moist, medium dense, massive to faintly stratified, scattered highly weathered (grus) andesite gravel and cobbles [Glacial Deposits]

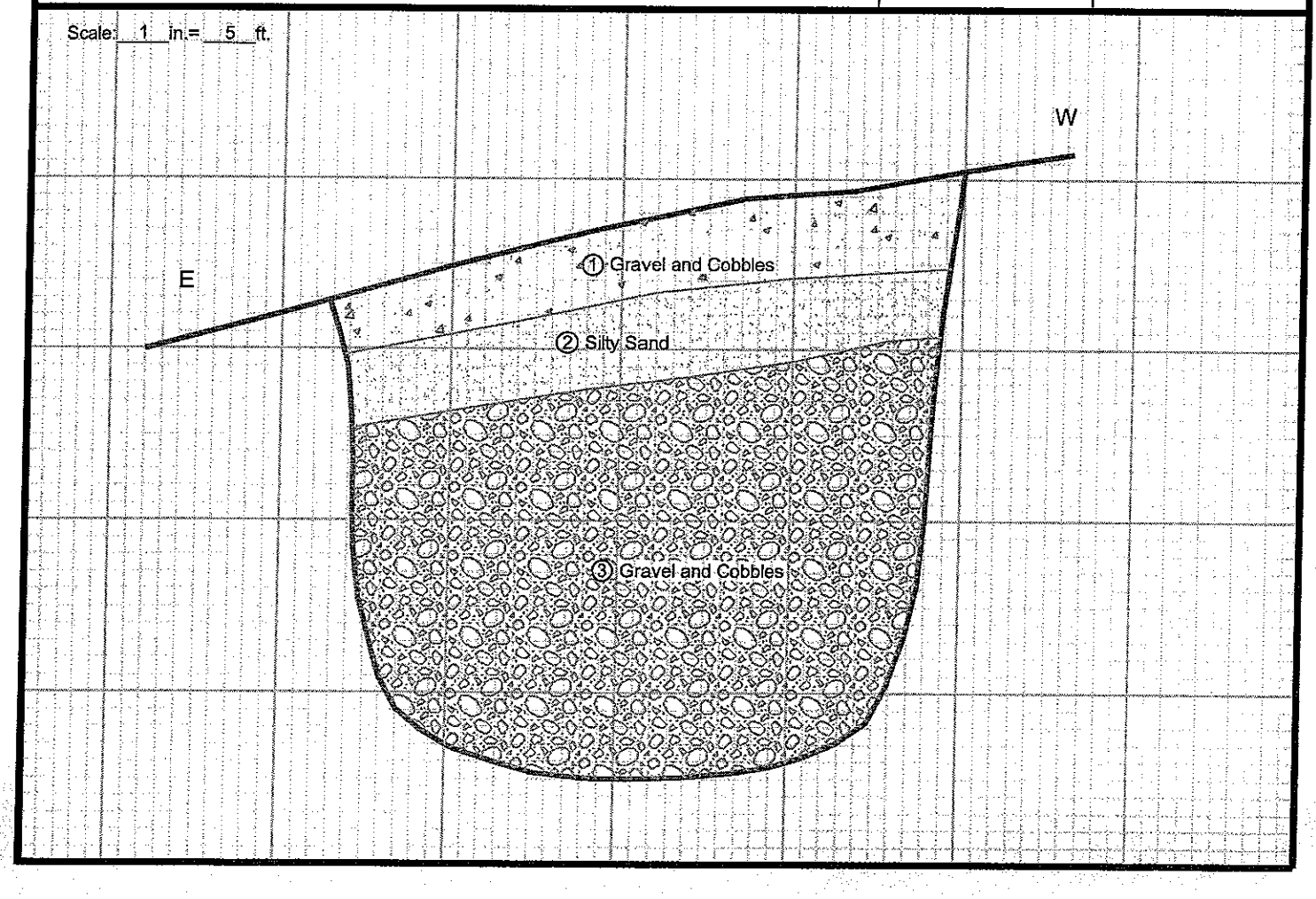
③ 4.7' - 18': GRAVEL and COBBLES with clayey sand to sandy clay matrix; medium brown to reddish brown, moist to very moist, medium dense, massive, about 60% subangular (some subrounded) gravel and cobbles to 7" in diameter (includes sandstone, siltstone, and andesite), about 40% fine- to coarse-grained sand and low plastic fines [Glacial Deposits]

ORIENTATIONS

SAMPLES

No Samples Collected

Note: Soil Classifications (USCS) based on field descriptions



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-16

PIT LOCATION: West portion of Lot 40, east edge of ski run

Approximate Pit Dimensions (feet): Length: 18 Width: 5 Depth: 17

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8154' Log View Direction: west

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 4': Gravelly Silty SAND; reddish brown, slightly moist, loose, stratified in 4" to 6" layers parallel to slope, angular to subangular andesite, sandstone, and shale gravel to 3" in diameter [Colluvium]

② 4' - 6.5': Silty SAND with scattered gravel; fine- to medium-grained, strong reddish brown, slightly moist, medium dense, massive [Glacial Deposits]

③ 6.5' - 14': GRAVEL and COBBLES with silty to clayey sand matrix; dark reddish brown, slightly moist, medium dense, massive, about 70% subangular sandstone, siltstone, shale, and andesite gravel and cobbles to 10" in diameter, about 25% sandy matrix [Glacial Deposits]

④ 14' - 15.5': Sandy Clayey GRAVEL to Gravelly CLAY; very dark brown, moist, very stiff and dense, massive, subrounded andesite gravel to 1 1/2" in diameter

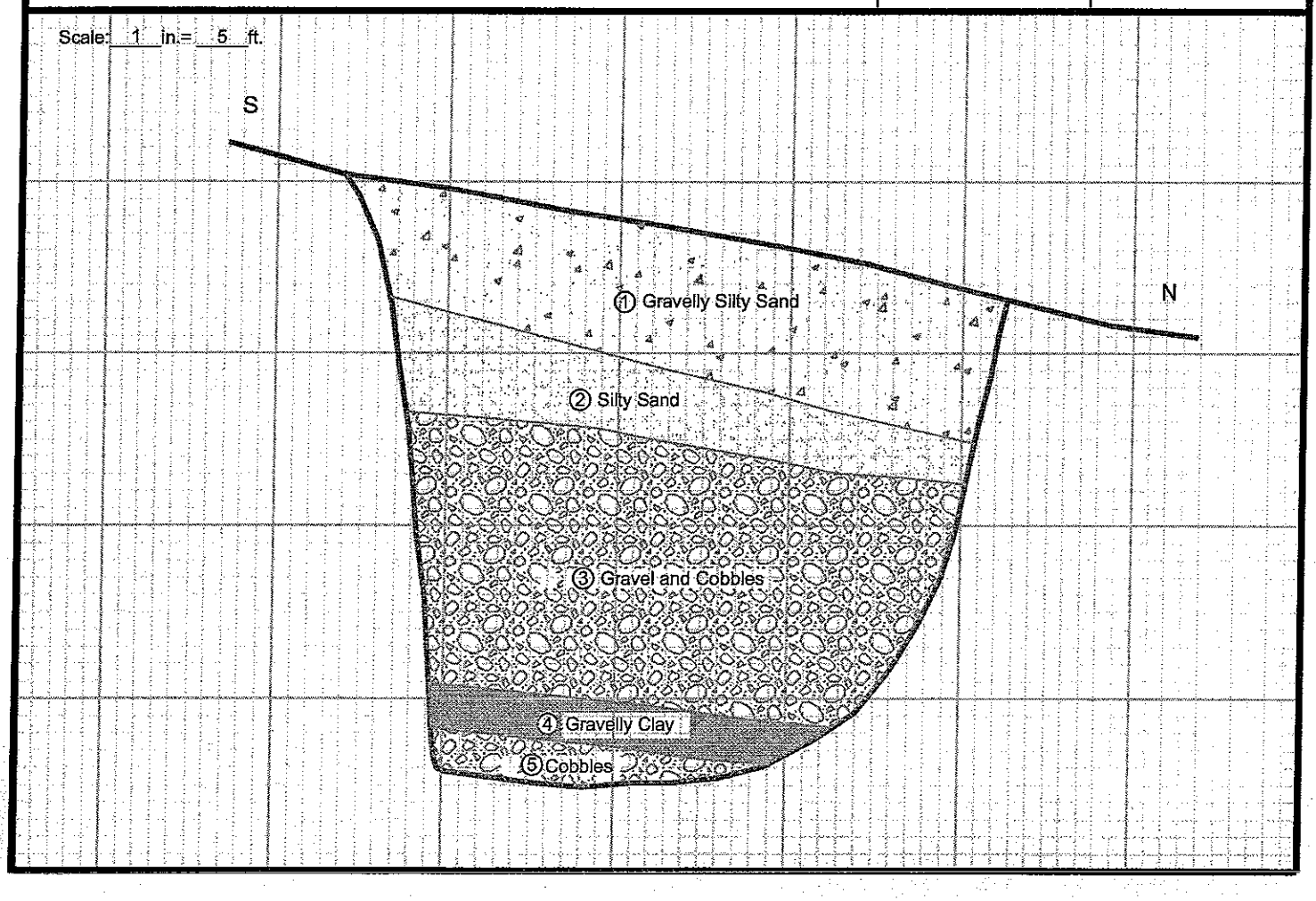
⑤ 15.5' - 17': GRAVEL and COBBLES with silty to clayey sand matrix; [Glacial Deposits]

Note: Soil Classifications (USCS) based on field descriptions

ORIENTATIONS

SAMPLES

No Samples Collected



PROJECT: Cowboy Heaven Phase 3A, Moonlight Basin Ranch , Big Sky, MT

TEST PIT: TP02-17

PIT LOCATION: West portion of Lot 39, east edge of ski run

Approximate Pit Dimensions (feet): Length: 15 Width: 5 Depth: 12

Date: 10-1-02 Logged By: gsv

Approximate Surface Elevation: ~8212' Log View Direction: west

Excavation Contractor: MBR Equipment: Deere 200 LC Excavator

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MATERIAL DESCRIPTIONS

① 0' - 2': Sandy GRAVEL; dark reddish brown, moist, loose, massive, angular to subangular gravel to 3" in diameter, scattered cobbles [Colluvium]

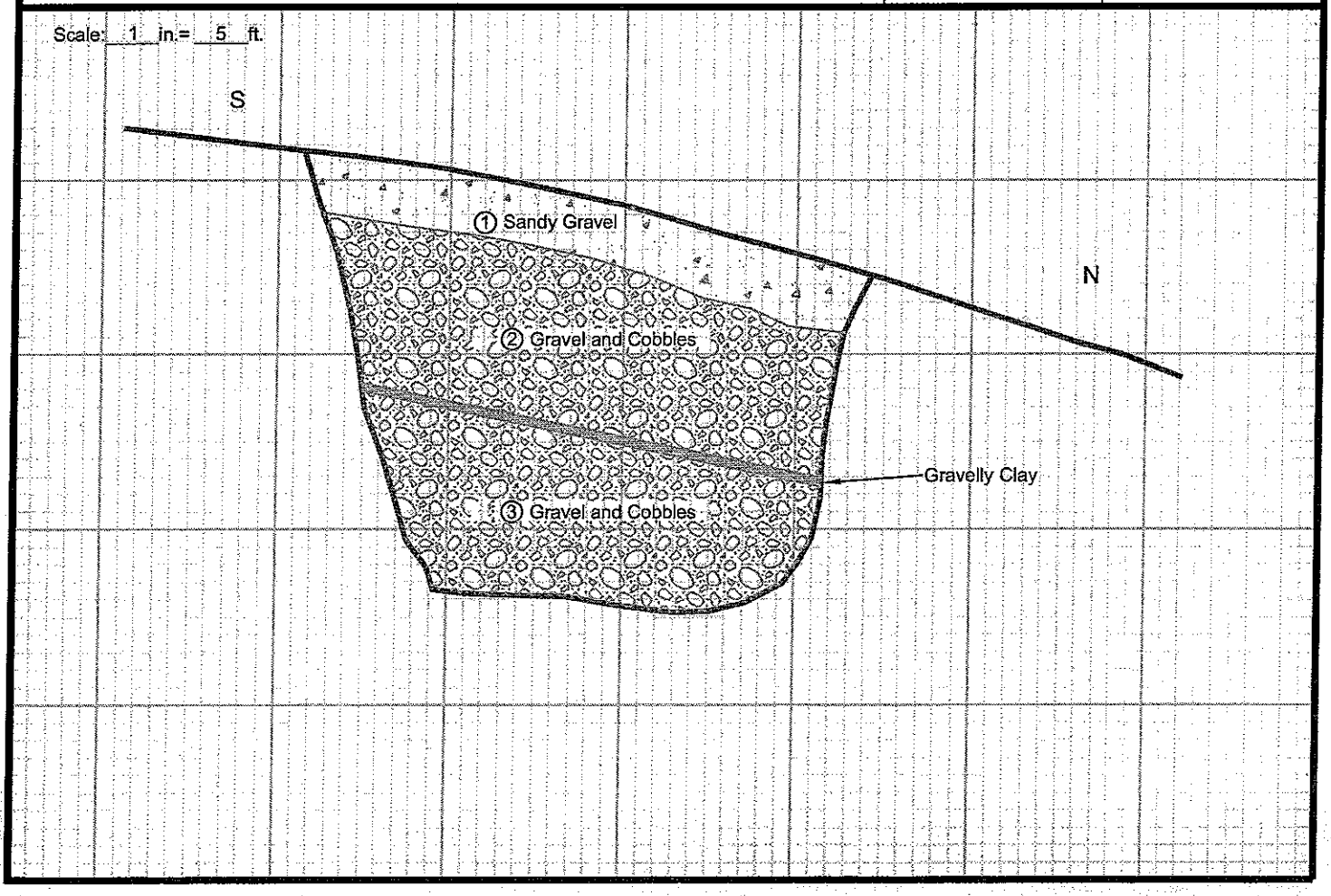
② 2' - 12': GRAVEL and COBBLES with silty sand matrix; dark reddish brown, slightly moist to moist, loose to medium dense, massive to stratified with 4" thick dark brown gravelly CLAY layer at 7', about 80% angular to subangular sandstone, siltstone, and andesite gravel and cobbles, scattered small boulders, about 20% silty fine- to medium- grained sand matrix [Glacial Deposits]

Note: Soil Classifications (USCS) based on field descriptions

ORIENTATIONS

SAMPLES

No Samples Collected



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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 9-5-02
PROJECT LOCATION: Cowboy Heaven Phase 3-B	HOLE NO.: BH02-7
TEST HOLE LOCATION: Approximately between Lots 46 and 47 of Cowboy Heaven Phase 3 Development	

ELEVATION G.S. (ft.): ~7828	TOTAL DEPTH (ft.): 50	GROUNDWATER LEVEL (ft.): 29	MEASURED FROM: Ground Surface
DRILL TYPE: CME 850	HAMMER: 140 # Automatic	DRILL CO: HazTech Drilling	DRILLER: Sam	LOGGED BY: gsv

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–4							COMMENTS: Drill with 8 1/2" OD, 4 1/4" ID hollow stem augers. Sample using 2" split-spoon sampler without liners, NW-rods, and 140 pound CME autohammer 0.0-12.0ft Clayey to Silty Sandy GRAVEL with cobbles; yellowish brown, slightly moist to very moist, medium dense, massive, subangular siltstone and andesite gravel to 1 1/2" [Landslide Debris]					
5		1	15	50								
6–9												
10		2	15	35								
11–13							12.0-24.0ft Gravelly Sandy CLAY; light yellowish brown to gray, slightly moist to moist, stiff to very stiff, plastic, massive, about 25% subangular to subrounded gravel to 3/4", 25% medium- to coarse-grained sand, 50% plastic fines [Landslide Debris]					
14		3	13	55								
15–19												
20		4	16	35								
21–24							24.0-38.0ft Clayey Sandy GRAVEL; brown, very moist to wet at 29', medium dense to dense, massive about 40% subangualr shale, siltstone, sandstone, and andesite gravel to 1 1/2", 35% medium- to coarse-grained sand, 25% plastic fines [Landslide Debris]					
25		5	30	55								
26–27												

TEST_HOLE_LOG2 MBR02.GPJ WOMACK.GDT 11/7/02

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch

DATE: 9-5-02

PROJECT LOCATION: Cowboy Heaven Phase 3-B

HOLE NO.: BH02-7

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
29												
30		6	38	35								
31												
32												
33												
34												
35		7	28	55								
36												
37												
38												
39							38.0-42.0ft CLAY; dark brownish gray, dry to slightly moist, hard, massive, reddish brown oxidation mottling [Residual Shale]					
40		8	58	100								
41												
42												
43							42.0-50.0ft SHALE; very dark gray, dry to slightly moist, weak, faintly laminated, extremely fractured, some red-brown mottling [Albino, Muddy, and Thermopolis Formation undifferentiated]					
44												
45		9	66	100								
46												
47												
48												
49												
50		10	50/3"	100								
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 9-6-02
PROJECT LOCATION: Cowboy Heaven Phase 3-B	HOLE NO.: BH02-8
TEST HOLE LOCATION: Approximately between Lots 47 and 48 of Cowboy Heaven Phase 3 Development	

ELEVATION G.S. (ft.): ~7820	TOTAL DEPTH (ft.): 55	GROUNDWATER LEVEL (ft.): 24	MEASURED FROM: Ground Surface
DRILL TYPE: CME 850	HAMMER: 140 # Automatic	DRILL CO: HazTech Drilling	DRILLER: Sam	LOGGED BY: gsv

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–27							COMMENTS: Drill with 8 1/2" OD, 4 1/4" ID hollow stem augers. Sample using 2" split-spoon sampler without liners, NW-rods, and 140 pound CME autohammer 0.0-29.0ft Silty to Clayey Sandy GRAVEL with cobbles; brown, slightly moist to moist, loose to medium dense, massive, siltstone, sandstone, and shale gravel [Landslide Debris]					
5			8	30								
10			8	55								
15			7	30								
20		1	29	30								
25			19	0								

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch | DATE: 9-6-02

PROJECT LOCATION: Cowboy Heaven Phase 3-B | HOLE NO.: BH02-8

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
29												
30		2	20	100			29.0-39.0ft Gravelly to Sandy CLAY; light brown to light gray, moist to very moist, very stiff, plastic (appears bentonitic), massive, some red-brown oxidation mottling [Landslide Debris]					
31												
32												
33												
34												
35		3	22	100								
36												
37												
38												
39												
40		4	59	40			39.0-44.0ft Clayey Sandy GRAVEL and COBBLES; brown, very moist, very dense, massive, angular broken sandstone gravel to 1 1/2" in diameter [Landslide Debris]					
41												
42												
43												
44												
45		5	56	100			44.0-49.0ft CLAY; dark brownish gray, moist, hard, massive [Residual Shale]					
46												
47												
48												
49												
50			50/4"	100			49.0-55.0ft SHALE; very dark gray, slightly moist, very weak, laminated to stratified with 1-3" layers of very fine sandy siltstone, closely to extremely fractured, weathered [Albino, Muddy, and Thermopolis Formation undifferentiated]					
51												
52												
53												
54		6	50/6"	100								
55												
56												
57												
58												
59												
60												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 9-6-02
PROJECT LOCATION: Cowboy Heaven Phase 3-B	HOLE NO.: BH02-9
TEST HOLE LOCATION: Approximately in the west-central portion of Lot 49, Cowboy Heaven Phase 3 Development	

ELEVATION G.S. (ft.): ~7830	TOTAL DEPTH (ft.): 45.5	GROUNDWATER LEVEL (ft.): 34	MEASURED FROM: Ground Surface
DRILL TYPE: CME 850	HAMMER: 140 # Automatic	DRILL CO: HazTech Drilling	DRILLER: Sam	LOGGED BY: gsv

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–27							COMMENTS: Drill with 8 1/2" OD, 4 1/4" ID hollow stem augers. Sample using 2" split-spoon sampler without liners, NW-rods, and 140 pound CME autohammer					
							0.0-10.0ft Sandy CLAY with scattered gravel; light brown to reddish brown, slightly moist, stiff, massive, angular sandstone gravel [Colluvium]					
4–5		1	14	80								
9–10		2	37	100								
							10.0-24.0ft Clayey Sandy GRAVEL; dark brown to brown to gray, slightly moist to moist, medium dense to dense, massive, angular shale, siltstone, and sandstone gravel [Landslide Debris]					
14–15		3	29	65								
19–20		4	37	75								
24–25		5	24	40								
							24.0-29.0ft Sandy GRAVEL; dark gray, dry, medium dense, massive, mostly angular siltstone gravel [Landslide Debris]					

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch

DATE: 9-6-02

PROJECT LOCATION: Cowboy Heaven Phase 3-B

HOLE NO.: BH02-9

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
29												
30		6	16	100			29.0-39.0ft Clayey to Silty Sandy GRAVEL; brown and dark gray, moist to wet at 34', medium dense, massive, angular shale gravel [Landslide Debris]					
31												
32												
33												
34												
35		7	16	80								
36												
37												
38												
39												
40		8	50/6"	100			39.0-45.5ft SHALE; very dark gray, dry to very moist at contact with gravel, very weak, laminated, extremely fractured, moderately to highly weathered, some reddish brown oxidation mottling [Albino, Muddy, and Thermopolis Formation undifferentiated]					
41												
42												
43												
44												
45		9	60	100								
46												
47												
48												
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch	DATE: 9-6-02
PROJECT LOCATION: Cowboy Heaven Phase 3-B	HOLE NO.: BH02-10
TEST HOLE LOCATION: Approximately in the southwest corner of Lot 26, Cowboy Heaven Phase 3 developement	

ELEVATION G.S. (ft.): ~7840	TOTAL DEPTH (ft.): 30.5	GROUNDWATER LEVEL (ft.): na	MEASURED FROM: na
DRILL TYPE: CME 850	HAMMER: 140 # Automatic	DRILL CO: HazTech Drilling	DRILLER: Sam	LOGGED BY: gsv

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
1–4							COMMENTS: Drill with 8 1/2" OD, 4 1/4" ID hollow stem augers. Sample using 2" split-spoon sampler without liners, NW-rods, and 140 pound CME autohammer 0.0-4.0ft Sandy GRAVEL and COBBLES; light brown, dry, loose, massive, sandstone and andesite clasts [Colluvium]					
5–10		1	53	100			4.0-24.0ft Clayey to Sandy GRAVEL; monolithologic (shale gravel), dark brownish gray, dry to slightly moist, medium dense to dense, massive, angular shale gravel with pockets of gray-brown sandy clay [Landslide Debris]					
		2	35	75								
11–15		3	31	65								
16–20		4	28	100								
21–25		5	15	100			24.0-29.0ft CLAY; brownish gray, moist, stiff to very stiff, massive, some reddish brown mottling [Residual Shale]					
26–27												

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TEST HOLE LOG

PROJECT NAME: Moonlight Basin Ranch | DATE: 9-6-02

PROJECT LOCATION: Cowboy Heaven Phase 3-B | HOLE NO.: BH02-10

DEPTH (ft.)	GRAPHICAL LOG	SAMPLE	S.P.T. (N) BLOWS/FT.	RECOVERY (%)	UNCONFINED STRENGTH (TSF)	CLASSIFICATION	DESCRIPTION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMITS (%)	PLASTICITY INDEX (%)	WELL COMPLETION
29												
30		6	61	100			29.0-30.5ft SHALE; very dark brownish gray, slightly moist, weak, laminated, extremely fractured, moderately weathered [Albino, Muddy, and Thermopolis Formnation undifferentiated]					
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